2019

EuroDendro

9–13 September 2019, Brno, Czech Republic

BOOK OF ABSTRACTS

EuroDendro 2019, Brno

MENDELU
1919—2019
100 years

EuroDendro 2019

9–13 September, 2019, Brno, Czech Republic

Book of Abstracts

Brno 2019

Acknowledgement
Project Indicators of trees vitality Reg. No. CZ.1.07/2.3.00/20.0265 is co-financed by the European Social Fund and the state budget of the Czech Republic.

This publication includes abstracts presented at the EuroDendro 2019 conference and will be available at http://eurodendro2019.mendelu.cz

Editors: Vladimír Gryc, Kyriaki Giagli, Tomáš Kolář, Eva Koňasová, Michal Rybníček, Hanuš Vavrčík

Recommended citation:
Gryc V, Giagli K, Kolář T, Koňasová E, Rybníček M, Vavrčík H (eds.). 2019. Book of Abstracts. EuroDendro Conference 2019, 9–13 September, 2019, Brno, Czech Republic. 158 p.

Mendel University in Brno, Zemědělská 1, 61300 Brno, Czech Republic

ISBN 978-80-7509-676-0

Foreword

Dear participants,
we are pleased to welcome you in Brno, Czech Republic, on behalf of the hosting institution, the Faculty of Forestry and Wood Technology at Mendel University in Brno. The Mendel University in Brno is celebrating its 100th year anniversary of existence in 2019. We are honoured to celebrate this outstanding jubilee by organizing the international conference EuroDendro 2019. At the same time, EuroDendro 2019 is the 20th jubilee international EuroDendro conference.

EuroDendro is a regular international conference intended for scientists, academics, students as well as enthusiasts interested in dendrochronology and its applications in archaeology, climatology, environmental sciences, ecology, human history, and geology. The conference is especially an international gathering providing researchers with the opportunity to share the latest research findings and novel ideas, to establish new collaborations, plan new projects or just meet colleagues.

We are pleased to have people from all over the world participating at the EuroDendro 2019 conference. More than a hundred twenty people coming from 38 countries, representing 85 Institutes in Europe, Asia, Africa, Australia as well as North and South America are coming to Brno.

We are very happy to see all of you here in Brno. It will make us even happier to introduce not only Brno city-centre to you but also the Czech countryside, culture and traditional gastronomy during our social programme. We wish you a nice stay, interesting talks and fruitful discussions in a relaxed atmosphere.

On behalf of the organising committee,
Vladimír Gryc

Ing. Miroslav Toman, CSc.
Minister of Agriculture of the Czech Republic

grants

p a t r o n a g e

to

international conference
„EuroDendro 2019“

Prague, February 2019

MINISTRY OF AGRICULTURE
OF THE CZECH REPUBLIC

Organising committee

Vladimír Gryc – Mendel University in Brno (gryc@mendelu.cz)
Kyriaki Giagli – Mendel University in Brno (giagli@mendelu.cz)
Tomáš Kolář – Mendel University in Brno/Global Change Research Institute CAS (koldatom@gmail.com)
Eva Koňasová – Mendel University in Brno (eva.konasova@gmail.com)
Michal Rybníček – Mendel University in Brno/Global Change Research Institute CAS (michalryb@post.cz)
Václav Treml – Charles University in Prague (treml@natur.cuni.cz)
Hanuš Vavrčík – Mendel University in Brno (vavrcik@mendelu.cz)

Scientific Committee

Allan Buras (Germany)
Ulf Büntgen (UK)
Marco Carrer (Italy)
Katarina Čufar (Slovenia)
Petr Dobrovolný (Czech Republic)
Dieter Eckstein (Germany)
Didzis Elferts (Latvia)
Jan Esper (Germany)
Ignacio García-González (Spain)
Holger Gärtner (Switzerland)
Michael Grabner (Austria)
Ute Sass-Klassen (Netherlands)
Kristina Sohar (Estonia)
Willy Tegel (Germany)
Kerstin Treydte (Switzerland)

Content

Programme

Monday 9.9.2019

17:00–20:00	Registration at Mendel University in Brno
18:00–22:00	Ice-breaker at Mendel University in Brno with possible visiting the botanical garden and arboretum

Tuesday 10.9.2019

8:15–9:00	Registration and poster hanging
9:00–9:30	Conference opening

Session 1 – Dendrochronological dating, human and forest history

chair	**Willy Tegel**
9:30–10:00	Keynote speaker – Kyncl, Josef: History of Dendrochronology in the Czech Republic
10:00–10:15	Nabais, Cristina: The choir of Santa Cruz church in Coimbra, Portugal: comparing written sources and dendrochronological dating
10:15–10:30	Grabner, Michael: Timber in Vienna – the difference between felling and building date
10:30–10:45	Gmińska-Nowak, Barbara: Upper Mustang master chronology. Dendrochronological analysis of ancient architecture of Kingdom of Lo (Nepal).
10:45–11:15	*Coffee break with posters*
chair	**Tomasz Wazny**
11:15–11:30	Barrett, Marie-Therese: Unraveling the story of an Early Medieval crannog through tree-ring analysis
11:30–11:45	Muigg, Bernhard: Dendroarchaeology of early medieval water mills
11:45–12:00	Christopoulou, Anastasia: Following Schliemann – Potential of the Peloponnese peninsula for dendroarchaeology
12:00–12:15	Oberhänsli, Monika: Dendrochronological dating of charcoal from high-altitude prehistoric copper mining sites in the Oberhalbstein Valley (Grisons, Switzerland)
12:15–12:30	Christie, Duncan: Inca rituals in the summits of the Andes of Atacama: a tale of the trees

12:30–12:45	Keck, John: Updating Holocene subfossil oak chronologies from Croatia and Bosnia-Herzegovina
12:45–14:00	*Lunch*

chair	**Michael Grabner**
14:00–14:15	Tegel, Willy: The prehistoric pile dwellings of the Lake Constance shore at Eschenz (CH) “Orkopf” from a dendroarchaeological perspective
14:15–14:30	Rybníček, Michal: World´s oldest dendrochronologically dated archaeological wood construction
14:30–14:45	Čufar, Katarina: Dendrochronological questions related to musical instruments
14:45–15:00	Doğan, Yasir: Tree-ring dating of some musical instruments from Turkey
15:00–15:15	Bernabei, Mauro: A Guarneri in the attic
15:15–15:30	Kusbach, Antonín: Pedoanthracological records as tools for revelation of the forest history in the Khan Khentii Mts., northern Mongolia
15:30–16:00	*Coffee break with posters*

Session 2 – Technical advances in dendrochronology and wood anatomy

chair	**Filipe Campelo**
16:00–16:15	Van den Bulcke, Jan: State-of-the-art multiscale X-ray CT scanning of increment cores
16:15–16:30	Lehnebach, Romain: X-ray CT analysis of wood formation: development and perspectives
16:30–16:45	García-González, Ignacio: Measuring and editing tree rings in ImageJ using the plugin TreeRingJ
16:45–17:00	Mikhailovich, Anna: Spatio-temporal dynamics of the upper tree line in the polar Urals: centuries-old downward and upward shift
17:00–21:00	Guided tour to the city center and dinner in the Pegas brewery

Wednesday 11.9.2019

Session 3 – Wood anatomy and tree phenology

chair	**Katarina Čufar**
9:00–9:15	Mayer, Konrad: A synoptic view on intra-annual density fluctuations

9:15–9:30 Pérez-de-Lis, Gonzalo: Can we chop a tree-ring into time-slices? What wood formation dynamics can bring to intra-annual tree-ring sciences.

9:30–9:45 Häusser, Martin: Differing effects of two consecutive extreme years on radial growth of pines along an elevation gradient on Corsica

9:45–10:00 Tumajer, Jan: Modelling intra-annual growth dynamics of *Picea abies* in treeline

10:00–10:15 Myśkow, Elżbieta: The impact of horse-chestnut leaf miner on cambial activity and differentiation of secondary conductive tissues of horse-chestnut

10:15–10:30 Fajstavr, Marek: Tree water status fluctuations directly affecting the xylem cell morphogenesis of drought-stressed Scots pine trees

10:30–10:45 Vieira, Joana: The effect of water manipulation on xylogenesis: adjusting rates rather than duration

10:45–11:15 Coffee break with posters

chair Vladimír Gryc

11:15–11:30 Zhu, Liangjun: Temperature rather than precipitation limits vessel features in earlywood and radial growth of Manchurian ash (*Fraxinus mandshurica* Rupr.) in temperate forests

11:30–11:45 García-González, Ignacio: Complex climate-growth relationships of ring-porous oaks are optimized by combining earlywood vessels and latewood width: some examples from northwestern Iberia

11:45–12:00 Krejza, Jan: Time lag between stem radial increment and stem carbon allocation and its consequences to net ecosystem production

12:00–12:15 Campioli, Matteo: Inter-individual variability in spring phenology of late successional temperate deciduous trees is determined by tree growth characteristics and previous year autumn phenology

12:15–12:30 Dox, Inge: New insights on autumn phenology of temperate deciduous trees: comparison of cessation of woody growth and onset of foliar senescence in autumn in the European beech and the silver birch along their distributional range in Europe

12:30–12:45 Bijak, Szymon: Does growing longer mean growing wider?

12:45–14:00 Lunch

14:15–22:00 Excursion to the the Lednice-Valtice Cultural Landscape (including dinner in a wine cellar)

Thursday 12.9.2019

Session 4 – Tree growth-climate variability relationship

chair Kerstin Treydte

9:00–9:30	Keynote speaker – Dobrovolný, Petr: Past climate from chronicles to trees and beyond
9:30–9:45	Yermokhin, Maxim: Impact of climatic factors on the radial increment of hornbeam and grey alder at the borders of their ranges
9:45–10:00	Treml, Václav: How coherent are stand-level tree growth trends and climate responses in conifer forests of Central Europe?
10:00–10:15	Trlin, Domagoj: Climate sensitivity of narrow-leaved ash in floodplains
10:15–10:30	Lyu, Lixin: Drought limitation on tree growth at the Northern Hemisphere's highest tree line
10:30–10:45	Žmegač, Anja: Climate sensitivity of black pine from mountainous coastal area in Croatia
10:45–11:15	*Coffee break with posters*

chair Václav Treml

11:15–11:30	Akkemik, Ünal: October–July precipitation reconstruction for Northern Kazakhstan since 1744
11:30–11:45	Malik, Rayees Ahmad: Climate reconstruction potential of pindrow fir tree rings from northwestern Himalaya
11:45–12:00	Sarir, Ahmad: A 424-year tree-ring based PDSI reconstruction of Deodar from Chitral HinduKush Range of Pakistan: linkages to the ocean oscillations
12:00–12:15	Kshetrimayum, Ghanashyam Singh: Tree ring analysis of himalayan cedar in relation to climate in sub-tropical moist forest of northeast India
12:15–12:30	Nongthombam, Dhirendra Singh: Tree ring formation and intra annual density fluctuation in relation to climate in a sub tropical pine forest
12:30–12:45	Férriz, Macarena: Understanding mortality in two co-occurring Mediterranean coniferous species of different drought-tolerance
12:45–14:00	*Lunch*

Session 5 – Tree growth responses to environmental stress

chair Ignacio García-González

14:00–14:15	Trouillier, Mario: Size, not age, affects trees' climate sensitivity

14:15–14:30 Huang, Weiwei: Predictions of future growth based on tree ring chronologies: How sure can we be?

14:30–14:45 Gennaretti, Fabio: Divergent tree physiological states in black spruce stands and their implications for millennial-long dendroclimatic reconstructions

14:45–15:00 Novak, Klemen: Aleppo pine forest decline in semiarid Mediterranean ecosystems in southeast Spain

15:00–15:15 Drobyshev, Igor: Variability in masting of European beech at different time scales: analysis of 329 year long dendrochronological reconstruction from Southern Sweden

15:15–15:30 Plichta, Roman: Beech seedlings are more prone to hydraulic dysfunction in spring than in summer

15:30–16:00 Coffee break with posters

chair Nesibe Köse

16:00–16:15 Kašpar, Jakub: Woody species-specific disturbance regimes and strategies in mixed mountain temperate forests in the Šumava Mts., Czech Republic

16:15–16:30 Čada, Vojtěch: Dendrochronological quantification of natural disturbances in the European mountain spruce forests as a guideline for management

16:30–16:45 Matulewski, Paweł: Methodological challenges and pitfalls in cross-dating of tree roots subjected to trampling (*Pinus sylvestris* L., NE Poland)

16:45–17:00 Begović, Krešimir: Are forests getting younger? A case study of environmental changes impact on growth dynamics of primary forests of Carpathians.

17:00–17:15 Phulara, Mohit: Response of alike tree species at different sites of IHR along treeline ecotone

17:15–17:30 Khan, Afsheen: Resilience in some lower Himalayan conifers under disturbed condition; a preliminary tree ring study of growth

17:30–17:45 Kemp, Marthie Elizabeth: Exploring the dendroecological potential of riparian Poplar trees, Caledon river, South Africa

Removing posters

19:00–23:00 Farewell dinner in Hotel International Brno

Friday 13.9.2019

Optional excursion to the Villa Tugendhat (10:00–14:00)

Departure

Oral presentation

OR01

History of dendrochronology in the Czech Republic

Kyncl, Josef[1]

[1]*DendroLab Brno, Czech Republic*
Correspondence: Josef.kyncl.dendro@gmail.com

Keywords: Czech Republic, dendrochronology, history

The development of dendrochronology in Central Europe can be divided into three periods: the beginnings (1930s to 1950s), the period of constructing chronologies (1960s and 1970s), and the modern period (from the 1980s to the present). The first period was characterized by the development of working methods and first dendrochronological experiments that resulted in the first chronologies mainly by the astronomer Bečvář and the climatologist Hanzlík. However, these initiatives ended because it was impossible to acquire capacity for a specialized workplace and the data have probably not been preserved. During the second period, especially fir and oak standard chronologies were compiled for large territorial units mainly due to activity of Bohuslav Vinš, who established a laboratory at the Forest Research Institute in Zbraslav. Most of his work concentrated on the structure and development of forest stands, quantifications of incremental losses of forests caused by industrial emissions of SO_2 type, gradual changes in response to changes in water regime in floodplain forests, and defoliation. Since the 1980s, a large amount of historical and prehistoric material and more sophisticated computing technology has made it possible to compile geographically „finer“ standard chronologies, also for spruce and pine. During the last two decades, multicentennial tree-ring chronologies for fir, spruce, pine and oak have been compiled. Currently, ten laboratories dealing with various dendrochronological research exist across the Czech Republic.

OR02

The choir of Santa Cruz church in Coimbra, Portugal: comparing written sources and dendrochronological dating

Pinto, Daniel[1]; Pereira, Gabriel[1]; Wázny, Tomasz[2]; García-González, Ignacio[3]; Craveiro, Maria de Lurdes[1]; Lopes, Conceição[1]; Nabais, Cristina[4]

[1]Centro de Estudos em Arqueologia, Artes e Ciências do Património (CEAACP), Universidade de Coimbra, Coimbra, Portugal
[2]Nicolaus Copernicus University, Faculty of Fine Arts, Institute of Study, Conservation and Restoration of Works of Art, Toruń, Poland
[3]Universidade de Santiago de Compostela, Departamento de Botánica, Escola Politécnica Superior de Enxeñaría, Campus Terra, Lugo, Spain
[4]Centre for Functional Ecology, Department of Life Sciences, Faculty of Sciences and Technology, University of Coimbra, Coimbra, Portugal
Correspondence: crnabais@bot.uc.pt

Keywords: choir, cultural heritage, provenance, tree rings, wood identification

The construction of the monastery of Santa Cruz started in 1131. Later, during the kingdom of D. Manuel (1495–1521), the monastery was subjected to several architectonic interventions. The choir, a project of the Flemish sculptor Olivier de Gant, was built ca. 1507. Around 1531, the construction of a balcony prompted a rearrange of the space, with the graves of the first two kings of Portugal being moved to the main chapel, and the choir to the church balcony. The French carpenter Francisco Lorete made eight new choir seats to fulfil the new space, respecting the layout of the Flemish sculptor. Thus, the construction of the choir is historically well dated and had two phases. Dendrochronology, besides dating the wood, can give a probable wood provenance. We carefully accessed 39 choir stalls from the two construction periods, polished the transversal section to highlight the tree rings, photographed and measured them using TreeRingJ (developed by García-González). The choir stalls were made of oak and had between 150 to 200 rings, crossdating with reference chronologies from the Baltic region. This new information is extremely valuable for the historical wood trade, and wood dating is in agreement with the two periods described in the written sources. Why it was not used local wood? Did the Flemish sculptor influence the wood to be used? Dendrochronology, combined with the written sources, can enrich the information about a wonderful piece of wood structure, the choir of Santa Cruz.

OR03

Timber in Vienna – the difference between felling and building date

Grabner, Michael[1]; Nemestothy, Sebastian[1]; Wächter, Elisabeth[1]; Mayer, Konrad[1]; Karanitsdch-Ackerl, Sandra[1]; Buchinger, Günther[2]

[1]University of Natural Resources and Life Sciences, BOKU, Vienna, Austria. Institute of WoodTechnology and Renewable Materials, Konrad Lorenz Strasse 24, 3430 Tulln, Austria
[2]Denkmalforscher, Margarethenstraße 82/22, 1050 Vienna, Austria
Correspondence: michael.grabner@boku.ac.at

Keywords: dendrochronology, tree felling, timber transport, rafting, building history

Apart from fuel wood, big amounts of timber were used for buildings. Depending on the size and location of the building, a more or less extended supply chain for timber was necessary. In the case of Vienna, the logs may have travelled as rafts via streams and rivers (Danube) to their final destination. At the forest, lumberjacks were felling the logs, which were often debarked still at the cutting site, making them lighter and more slippery and therefore easing transport.

In this presentation the time of felling according to old literature and still visible evidence on beams in historical constructions is discussed.

Beams with a waney edge usually do not show remnants of bark or bast fibers – indicating the felling at the beginning of spring-time. 65% of the beams sampled in Vienna with waney edge had a complete outermost ring with latewood. That means that the trees were felled between September and April of the following year. Log driving was depending on huge amounts of water available during snow melting. The main season of rafting was between March and early December. The temporal differences between the felling dates of the Viennese timber constructions are therefore based on possible losses of time due to felling, log driving and rafting.

With the help of 24 selected examples from Vienna, for which both, exact felling data and archive-assured building data are available, it can be shown that this difference is limited to two to four years.

OR04

Upper Mustang master chronology. Dendrochronological analysis of ancient architecture of Kingdom of Lo (Nepal).

Gmińska-Nowak, Barbara[1]; Ważny, Tomasz[1]

[1]Nicolaus Copernicus University in Toruń, Faculty of Fine Arts, Institute for the Study, Conservation and Restoration of Cultural Heritage, ul. Sienkiewicza 30/32, 87-100 Toruń, Poland
Correspondence: barbara.gminska@gmail.com

Keywords: Upper Mustang, dendroarcheology, buddhist architecture, reuse of timber

Upper Mustang situated in Nepal, known as the ancient Himalayan Kingdom of Lo is a land of extraordinary, precious, tangible and intangible cultural heritage. Ancient Buddhist architecture preserved in Upper Mustang is a rich source of historical wood valuable for dendrochronological research. Dendroarchaeological study in the area was initiated in 2015. In 2018 it was resumed in the cooperation with the Department of Archaeology in Kathmandu. The aim of the research was to develop chronologies suitable for dating historical wood from the territory of Kingdom of Lo. We gathered precious collection of over 190 pcs of wood from the oldest building in Upper Mustang. The material enabled us to develop the chronology of pine that reach 1317. We dated wood collected in buildings of a great historical and cultural importance: Thupchen Gompa and Jampa Lakhang of Lo Mathang, Ghar Gompa of Lo Gekhar, Namgyal Monastery, Thinggar Monastery, ruins of Samdroling Monastery and King Palaces of Lo Mantahng, Thinggar and Tsarang. The results of dendrochronological analysis revealed that all investigated buildings are composed of wood coming from several periods and different localities. Our results confirm that during restoration of the most important structures in Lo, timber was very often replaced with new. Removed timber was widely reused in other buildings both historical and new constructed.

Acknowledgement

Research are funded by the National Science Centre, Poland (2013/11/N/HS3/04912).

OR05

Unraveling the story of an Early Medieval crannog through tree-ring analysis

Barrett, Marie-Therese[1]; Plunkett, Gill[1]; Brown, David[1]

[1]Queen's University Belfast, Archaeology & Palaeoecology, School of Natural and Built Environment, BT7 1NN, Northern Ireland.
Correspondence: mbarrett08@qub.ac.uk

Keywords: Alnus glutinosa Gaertn, archaeology, short sequences, Crannog, Early Medieval

Crannogs (artificial islands/lake settlements) are valuable resources because they are rich in preserved waterlogged deposits. The dating and chronology of these sites (1,200 recorded in Ireland) is key to understanding Early Medieval Ireland in a meaningful way. In total 31 Irish crannogs have been dated by dendrochronology. A large number of these dates represent spot dates rather than information about the construction or evolution of sites. Here we show that an annual tree-ring chronology can be achieved for Drumclay crannog, a site in the north of Ireland. The excavation of this site exposed a vast number of well-preserved waterlogged archaeological features (7 m depth). Alder was the dominant species used in construction and oak timbers were used scarcely. While the oak timbers have provided spot dates, a much fuller chronological picture is being revealed by analysis of the alder samples, particularly with respect to understanding construction phases and site evolution. The results are revealing the pace at which the site developed and are providing a high resolution view of crannog evolution in time and space. Here we show that it is possible to scrutinise life in Early Medieval at an annual resolution using a combination of tree-ring analysis of alder timbers, radiocarbon dating and wiggle matching, with close analysis of the archaeological record. This multidisciplinary approach allows us to consider life on the crannog at a timescale relevant to human history. We anticipate that this approach will provide new theoretical perspectives with which to understand Early Medieval settlement in Ireland.

OR06

Dendroarchaeology of early medieval water mills

Muigg, Bernhard[1]; Tegel, Willy[2];
Rohmer, Pascal[3]; Schmidt, Uwe Eduard[4]; Büntgen, Ulf[5]

[1]Albert-Ludwigs-University Freiburg, Institute of Forest Science, Chair of Forest History, Tennenbacher Straße 4, 79106 Freiburg, Germany
[2]Albert-Ludwigs-University Freiburg, Institute of Forest Science, Chair of Forest Growth and Dendroecology, Tennenbacher Straße 4, 79106 Freiburg, Germany
[3]Institut National de Recherches Archéologiques Préventives (INRAP), 10 Rue d'Altkirch, 67100 Strasbourg, France
[4]Albert-Ludwigs-University Freiburg, Institute of Forest Science, Chair of Forest History, Tennenbacher Straße 4, 79106 Freiburg, Germany
[5]University of Cambridge, Department of Geography, Downing Place Cambridge CB2 3EN, United Kingdom
Correspondence: bernhard.muigg.@wfg.uni-freiburg.de

Keywords: milling technology, Early Middle Ages, dendroarchaeology, archaeomolinology, water mill

The application of hydropower in milling steadily increased over large parts of Europe from the Early Middle Ages onwards. Since there is no written information on the technical design of early medieval water mills, archaeological excavations are the only way to gain unique insights into their evolution. Structural remnants of water mills are generally found in waterlogged sediments, resulting in an increased probability of wood preservation, however, usually as pile groups without recognisable structures and dislocated timber scattered randomly across the excavation site.
The precision of annually resolved dendrochronological dating permits to identify individual phases of construction within one mill site. Dendroarchaeological studies are further based on information on the timber used (e.g. species selection, tree age) and observations of tool marks and technical details of wooden remains. Here we present dendroarchaeological results from a 9th century water mill from Audun-le-Tiche, northern France. The exceptional number of structural elements, including a well-preserved waterwheel segment, allows for detailed reconstructions of the technical design and the evolution from one-piece paddles to composite forms. Placing our results in the context of other early medieval mills, suggests a rather uniform construction design within, though different beyond the Frankish Empire. Well-preserved wooden finds from continental Europe providing information on technical features of water mills are, however, extremely rare. Further archaeological discoveries are expected to enable a more differentiated picture in a wider, pan-European context.

References

Muigg, B., Tegel, W., Rohmer, P., Schmidt, U.E., Büntgen, U., 2018. Dendroarchaeological evidence of early medieval water mill technology. Journal of Archaeological Science 93, 17–25.

Acknowledgement

B.M. and W.T. received funding from the German Research Foundation (DFG), project TE 613/3-1. The authors thank Michael Kempf and Jürgen Rebmann for graphical support.

OR07

Following Schliemann – Potential of the Peloponnese peninsula for dendroarchaeology

Christopoulou, Anastasia[1]; Ważny, Tomasz[2]; Vasilogamvrou, Adamantia[3]; Karadimas, Nektarios[4]

[1]Institute for the Study, Conservation and Restoration of Cultural Heritage, Nicolaus Copernicus University, Toruń, Poland
[2]Institute for the Study, Conservation and Restoration of Cultural Heritage, Nicolaus Copernicus University, Toruń, Poland & Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA
[3]Emerita Director of Antiquities, Hellenic Ministry of Culture
[4]University of Crete
Correspondence: anchristo@umk.pl

Keywords: Bronze Age, Mycenaean civilization, timber, charcoal, Peloponnese, Greece

Several dendroecological studies are available from the Mountains of the Peloponnese region, while thorough studies from historical buildings and archaeological sites remain very limited. The study of a well-preserved piece of juniper with 250 rings from Shaft Grave V at Mycenae, excavated by Heinrich Schliemann in 1876, but still undated, inspired us to take a closer look on the potential of Peloponnese peninsula, home of the Bronze Age Mycenaean culture, for dendrochronology. In the context of the Balkan-Aegean Dendrochronology Project: «Tree-Ring Research for the Study of SE-European and East Mediterranean Civilizations» we carried out dendroarchaeological surveys both in historical buildings and archaeological excavation sites throughout the Peloponnese. Among others we examined timbers from Byzantine and post-Byzantine buildings, as well as charcoal pieces from the Late Bronze Age site of Ayios Vasileios, a new Mycenaean palace, located south of Sparta. Our findings so far suggest that both local and imported timber, mainly conifers, was used for historical buildings, while the presence of rather unexpected species like the tropical hardwood Azobé (Lophira alata) was also recorded in some cases. Charcoal pieces from Ayios Vasileios correspond to local timber, including low altitude Aleppo pine (*Pinus halepensis*), high altitude Black pine (*Pinus nigra*) with narrow rings useful for dendrochronology, but also deciduous oaks (*Quercus* spp.). Through the systematic study of this region we hope to solve the mystery of Schliemann's juniper from the Shaft Grave V and follow the rise of the Mycenaean civilization.

Acknowledgement

The study is realized with financial support of the National Science Centre, Poland (Grant Nr. 2016/22/A/HS3/00285).

OR08

Dendrochronological Dating of charcoal from high-altitude prehistoric copper mining sites in the Oberhalbstein Valley (Grisons, Switzerland)

Oberhänsli, Monika[1]; Seifert, Mathias[1]; Bleicher, Niels[2]; Schoch, Werner H.[3]; Reitmaier-Naef, Leandra[4]; Turck, Rouven[4]; Reitmaier, Thomas[1]; Della Casa, Philippe[4]

[1]Laboratory for Dendrochronology, Archaeological Service of the Canton of Grisons, Loëstrasse 26, CH-7001 Chur, Switzerland
[2]Laboratory for Dendrochronology, City of Zurich, Seefeldstrasse 317, CH-8008 Zurich
[3]Laboratory for Ancient Wood Research, Unterrütistrasse 17, CH-8135 Langnau am Albis, Switzerland
[4]University of Zurich, Institute of Archaeology, Department of Prehistoric Archaeology, Karl Schmid-Strasse 4, CH-8006 Zurich, Switzerland
Correspondence: monika.oberhaensli@adg.gr.ch

Keywords: anthracology, high-altitude sites, copper mining, charcoal production, Late Bronze Age and Early Iron Age

From 2013 to 2018, the prehistoric copper mining region of Oberhalbstein was the focus of archaeological research carried out by the Department of Prehistoric Archaeology at the University of Zurich. The surveys and excavations unexpectedly yielded numerous large, well-preserved charcoal fragments from conifers (*Picea abies*/*Larix decidua*, *Pinus cembra*, *Pinus mugo*/*sylvestris*). Because most of the sites were located between 1700 m and 2450 m a.s.l., the larger charcoal fragments bore up to 200 tree rings due to the low level of tree growth at such high altitudes, and even fairly small fragments had a considerable number of rings. As a consequence, dendrochronological analysis became a key component in the research project.
A total of 534 charcoal fragments and 7 wooden objects were retrieved from the 23 sites studied. Dendrochronological analysis allowed to construct two conifer chronologies that correlated with those from the central and eastern Alps and covered the period between the 12th and the 7th centuries BC, which included the Hallstatt plateau. The absolute chronological framework showed that prehistoric copper mining and production in this part of the central Alps was taking place during the Late Bronze Age and the Hallstatt period.

Acknowledgement

The investigations were undertaken as part of the international research project „Prehistoric copper production in the eastern and central Alps – technical, social and economic dynamics in space and time“, with the support of the Austrian Science Fund (FWF), the Swiss National Science Foundation (SNF) and the German Research Foundation (DFG), and the participation of the Department of Prehistory of the University of Zurich, the Archaeological Service of the Canton of Grisons, the Deutsches Bergbau-Museum Bochum and the HiMAT Research Center of the University of Innsbruck. We would like to thank Kurt Nicolussi (Laboratory for Dendrochronology, University of Innsbruck) and Niels Bleicher (Laboratory for Dendrochronology, City of Zurich) for their support in the evaluation of dendrochronological results.

OR09

Inca rituals in the summits of the Andes of Atacama: a tale of the trees

Christie, Duncan[1]; Berenguer, José[2]; de-Pol, Ricardo[3]; Alvarez, Claudio[1]; Morales, Mariano[4]; Villalba, Ricardo[4]; Ibacache, Sebastian[2]; Flores, Felipe[1]; Aliste, Diego[1]; Velázquez, Gonzalo[1]; Santos, Guaciara[5]; Ancapichún, Santiago[6]; Cuq, Emilio[1]

[1]Laboratorio de Dendrocronología y Cambio Global, Universidad Austral de Chile, Valdivia, Chile
[2]Museo Chileno de Arte Precolombino, Chile
[3]Universidad de Magallanes, Chile
[4]Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, Argentina
[5]University of California, USA
[6]Universidad de Concepción, Chile
Correspondence: duncanchristie@gmail.com

Keywords: dendroarchaeology, Andes, Incas

Fluctuations in the availability of water resources represents the main factor which has modulated ecosystem dynamics, human population changes and culture in arid and semiarid regions. One of the largest high-altitude semiarid regions of South America is the Altiplano plateau in the Central Andes (~14°S-26°S). With a mean elevation of 4.000 m a.s.l. and many volcanoes up to 6.700 m a.s.l., the Altiplano has been the physical environment for the settlement of many local communities who have inhabited the region for thousands of years. Historically, human activities in the Altiplano have been strongly modulated by variations in climate, particularly water availability.
During the last decade, tree-ring research has been developed in this region allowing the reconstruction of the dynamics of water resources at annual resolution during the last millennia. In the other hand on the mountain tops of the Altiplano exists many high-altitude pre-Columbian sanctuaries which are framed within the remarkable relationship between mountains and water, which was a fundamental feature on which local cultures of the Altiplano based their complex religious beliefs related to mountains as sources of water and fertility. The existence of archaeological wood on this sites utilized as offerings and/or firewood, and the possibility to develop regional tree-ring chronologies in the area allow the tree-ring dating and the development of precipitation reconstructions. On this investigation we present a new tree-ring based regional precipitation reconstruction for the Altiplano for the last millennia, and the dating of three high-altitude sanctuaries located on mountain tops at ~6,000 m a.s.l. utilizing tree-ring widths and 14C wiggle-matching of tree-ring sequences. For the last, we utilize a recently developed regional 14C curve from the Altiplano region. The dating and occupancy of these water-related sanctuaries will contribute to a better understanding of the relationship between humans' religious beliefs and the semiarid environment that inhabited, on which century-scale dry periods are demonstrated to be a recurrent feature in the regional climate.

OR10

Updating Holocene subfossil oak chronologies from Croatia and Bosnia-Herzegovina

Keck, John R.[1]; Pearson, Charlotte L.[1]; Wazny, Tomasz[1]; Martin, Jacob[1]; Christopoulou, Anastasia[2]; Durman, Aleksander[3]

[1]Laboratory of Tree-Ring Research, University of Arizona
[2]National and Kapodistrian University of Athens
[3]University of Zagreb
Correspondence: jrkeck@email.arizona.edu

Keywords: Quercus, subfossil, radiocarbon, sequence building

This presentation provides an update on constructing multimillennial tree-ring sequences from subfossil oak samples dredged from the Sava River and its tributaries in Posavina, on both sides of the border between Croatia and Bosnia-Herzegovina in the Western Balkans. The data gathered from these samples offer the potential to provide a new dating and paleoenvironmental resource in this complicated region from a climatological and hydrological perspective. Using tree-ring series analyses and radiocarbon dating, we have identified 18 unique chronological groups, including 3 new chronological sequences, and have provided more robust replication for at least five chronological sequences spread throughout the last 8,000 years. This update builds on previously published high-resolution data for chronological and paleoenvironmental reconstructions in the region and continues to promise the potential to bridge floating tree-ring chronologies in the wider Eastern Mediterranean region and millennia-long continuous chronologies from central Europe.

References

Pearson, Ch.L., Wazny, T., Kuniholm, P.I. , Botic, K., Durman, A., Seufer., K., 2014. Potential for a new multimillennial tree-ring chronology from subfossil Balkan river oaks. Radiocarbon 56, 51–59.

Cufar, 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.

OR11

The prehistoric pile dwellings of the Lake Constance shore at Eschenz (CH) "Orkopf" from a dendroarchaeological perspective

Tegel, Willy[1]

[1]*Amt für Archäologie Thurgau, Frauenfeld, Switzerland*
Correspondence: tegel@dendro.de

Keywords: Alpine lacustrine archaeology, dendroarchaeology, Neolithic pile-dwellings, Neolithic woodland use, Neolithic settlement history, underwater archaeology, waterlogged wood

Hundreds of pile-dwelling settlements from Neolithic and Bronze Age (~4000– 800 BC) on lakeshores and peatbogs around the alps have been archaeologically studied and are today part of UNESCO cultural world heritage. These waterlogged sites constitute one of the most important prehistoric sources for dendroarchaeological studies, due to the excellent preservation conditions of organic material and in particularly wood. Combined with information of extensive under-water archaeological investigations, the dendroarchaeological research of wooden architectural elements, enables a detailed insight into former construction techniques and spatial development of prehistoric villages over centuries.

Here we present annually resolved and absolutely dated dendroarchaeological evidence for settlement activities of the site Eschenz (CH) "Orkopf" at the outflow of Lake Constance in the river Rhine. This exposed area in a shallow water zone formed peninsula conditions in some periods and was repeatedly settled between ~4000 and ~1500 BC. A total of 3478 wooden piles from buildings, fences, and fishing constructions were documented, sampled and studied during ten campaigns of under-water excavations (2007–2017). The dating results reveal settlement phases and insights into woodland and timber use, woodworking techniques, architecture, building and settlement structures for certain prehistoric period. Moreover, we compare proxies from several accurately dated Alpine climate archives – glaciers, treeline, tree rings – with our archaeological pile dwelling record from the 4th millennium BC to investigate if climate variability may have had an impact on the Neolithic settlement evolution.

OR12

World's oldest dendrochronologically dated archaeological wood construction

Rybníček, Michal[1,2]; Kočár Petr[3]; Muigg, Bernhard[4]; Peška, Jaroslav[5]; Sedláček, Radko[1]; Tegel, Willy[4]; Kolář, Tomáš[1,2]

[1]Department of Wood Science, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 61300 Brno,
[2]Czech Republic and Global Change Research Institute of the Czech Academy of Sciences, Bělidla 986/4a, 60300 Brno, Czech Republic
[3]Archaeological Centre Olomouc, U Hradiska 42/6, 77900 Olomouc, Czech Republic and Institute of Archaeology of the Czech Academy of Sciences, Letenská 4, 11801 Praha, Czech Republic
[4]Institute of Forest Sciences, University of Freiburg, Tennenbacher Str. 4, 79106 Freiburg, Germany
[5]Archaeological Centre Olomouc, U Hradiska 42/6, 77900 Olomouc, Czech Republic
Correspondence: michalryb@post.cz

Keywords: Central Europe, dendrochronology, Early Neolithic, oak, water well

In 2018, during the construction of a motorway in the East Bohemian Region near the town of Ostrov (Czech Republic), archaeologists excavated a structure of a wooden water well lining with a square base area of 80x80 cm and 140 cm in height. Due to the excellent conservation of the oak timbers, studies of technological details and precise tree-ring dating were possible. The used trees were felled in the years 5256/55 BC, which makes this well the oldest dendrochronologically dated archaeological wooden construction worldwide. It is the third well from the Early Neolithic period that has been discovered in the Czech Republic within the last four years. The design consists of grooved corner posts with inserted planks. This type of construction reveals advanced technical know-how and, till now, is the only known type from this region and time period. Thanks to the combination of annually resolved and absolutely dated tree-ring widths (TRWs), the Czech oak TRW chronology has been significantly extended back to 5481 BC. Wood anatomical identification of fragments from the well filling show mainly oak (*Quercus* spp.) and hazel (*Corylus* spp.), indicating a local forest composition dominated by these taxa. The shape of the individual structural elements and tool marks preserved on their surface confirm sophisticated carpentry skills. Based on these observations, we established a model for the „chaîne opératoire" from forest utilization to the final artefact at the beginning of the Early Neolithic period.

Acknowledgement

The paper was prepared within the Czech Republic Grant Agency through grants numbered GA18-11004S, Extension of the Czech Millennia-long Oak Tree-ring width Chronology; and the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPUI), grant number LO1415.

OR13

Dendrochronological questions related to musical instruments

Čufar, Katarina[1]; Bernabei, Mauro[2]; Grabner, Michael[3]; Mayer, Konrad[3]; Novak, Klemen[1]; Merela, Maks[1]

[1]University of Ljubljana, Biotechnical Faculty, department of Wood Science and Technology, Jamnikarjeva 101, 1000 Ljubljana, Slovenia
[2]National Research Council of Italy, Trees and Timber Institute, Via Biasi 75, 38010 – San Michele all'Adige (Trento), Italy
[3]University of Natural Resources and Life Sciences, Vienna, Institute of Wood Technology and Renewable Materials, Konrad Lorenz-Straße 24, 3430 Tulln an der Donau, Austria
Correspondence: katarina.cufar@bf.uni-lj.si

Keywords: dendrochronology, musical instruments, Picea abies, teleconnection

Recent activities of international interdisciplinary community under COST action Wood Musick, showed an increased interest for dendrochronology, which can be applied on resonance boards of string instruments made of Norway spruce (*Picea abies*) (1). We will present some main questions of wood music and tree-ring communities, and possible answers. Wood music community mainly addresses dendrochronology to define the age of instruments and whether they are genuine or fake. Dendrochronology, on the other side, has to solve the questions how to recognize and properly measure the tree-rings and which reference chronology to use. Some of the chronologies are freely available via ITRDB, however most of laboratories rely on own chronologies developed for particular purposes. Tree-ring community is challenged to constantly improve the network of chronologies for more reliable dating and for dendroprovenancing, especially if instruments are made of wood growing outside the traditional areas of resonance wood (2). We also need to improve the understanding of the Δt, i.e. time difference between tree felling, instrument production and dating – terminus post quem (1, 3). An important aspect is to use dendrochronology for the attribution to particular instrument maker or instrument making school. This is also related to the choice of wood. When an instrument maker found resonance wood of adequate quality, the wood of the same tree and provenance could be used for a great number of instruments. We will illustrate the topic with examples from the SE Alpine area including Italy, Austria and Slovenia.

References

Bernabei, M., Čufar, K. 2018. Methods of Dendrochronology for Musical Instruments. In: Pérez, M.A., Marconi, E. (Eds.) Book of End of WoodMusICK COST Action FP1302, 67–80.

Bernabei, M., Bontadi, J., Čufar, K., Baici, A. 2017. Dendrochronological investigation of the bowed string instruments at the Theatre Museum Carlo Schmidl in Trieste, Italy, Journal of Cultural Heritage 27S, 55–62.

Čufar, K., Beuting, M., Demšar, B., & Merela, M. 2017. Dating of violins – the interpretation of dendrochronological reports, Journal of Cultural Heritage 27S, 44–54.

OR14

Tree-ring dating of some musical instruments from Turkey

Doğan, Yasir[1]; Akkemik, Ünal[1]; Köse, Nesibe[1]

[1]Istanbul University-Cerrahpasa, Faculty of Forestry, Forest Botany Department, 34473 Bahceköy – Sarıyer, Istanbul
Correspondence: uakkemik@istanbul.edu.tr

Keywords: tree-ring, dating, oud, violin, kemancha

The purpose of this presentation is to present the results of 16 musical instruments, which are nine ouds, five kemanchas and two violins from Turkey. After coding the studied musical instruments, we took high resolution photos from bellies of these instruments, and tree-rings were sectioned five year-by-five year. Then measurements were performed on scaled photos using ImageJ program. For each instrument, standardized tree-ring series was built by using ARSTAN program. Reference chronologies of *Pinus nigra* JF Arnold, *Picea abies* (L) H. Karst., *Picea orientalis* (L.) Link. and *Abies* spp. from ITRDB were used in dating.

Four of eight kemanchas were dated; KMC02 to 1928 with ITAL010 (*Abies* sp.), KMC03 to 1811 with HAC (*Pinus nigra*) from Turkey, KMC04 to 1979 with TURK003 (*Picea orientalis*), and KMC05 to 1941 with LITH009 (*Picea abies*). The violin coded as KMN01 was dated to 1858 with POLA001, POLA019 and POLA020 (*Picea abies*), and the second one (KMN02) to 1933 with FRAN018 (*Picea abies*). One of the nine ouds could be dated; UD07 to 1961 with GRE004 (*Abies* sp.) and ITAL010 (*Abies* sp.). Finally, 50% of the studied musical instruments were been able to dated.

Results showed that (1) the musical instruments studied were from many different countries, (2) Dating of the ouds were generally problematic because of very likely lacking enough reference chronologies, (3) Woods of kemancha were diverse as black pine, fir and spruce on their bellies, (4) As conclusion, for more successful oud dating we need more chronologies from north countries of Black Sea.

OR15

A Guarneri in the attic

Bernabei, Mauro[1]

[1]*National Research Council of Italy, Trees and Timber Institute, Via Biasi 75, 38010 – San Michele all'Adige (Trento), Italy*
Correspondence: bernabei@ivalsa.cnr.it

Keywords: violin, Guarneri, musical instruments, attribution, resonance wood

A violin has been dated by the dendrochronological analysis of its wood. Its date, with a final year ring of 1694, would indicate an ancient artefact, from the early period of classical violin-making by famous luthiers such as the great masters Amati, Guarneri and Stradivari. By comparing the violin's year rings with the dendrochronological series of the violins of these great luthiers, the instrument was attributed with certainty to Joseph Guarneri filius Andreae. Analogies with the dendrochronological series of some of his instruments prove that the violin's wood came from the same tree trunk – common practice amongst violin-makers when they found wood that was particularly suitable for musical instruments. The instrument has now been valued at about two million euros. The discovery was made only thanks to dendrochronology, without involving other disciplines or taking into account stylistic considerations or characteristics of construction.

References

Bernabei, M., Bontadi, J., Rossi Rognoni G., 2010. A dendrochronological investigation of stringed instruments from the collection of the Cherubini Conservatory in Florence, Italy. Journal of Archaeological Science 37, 192–200.

Bernabei, M., Bontadi, J., Čufar, K., Baici, A. 2017. Dendrochronological investigation of the bowed string instruments at the Theatre Museum Carlo Schmidl in Trieste. Journal of Cultural Heritage 27S, S55–S62.

Bernabei, M., Čufar, K. 2018. Methods of Dendrochronology for Musical Instruments. In: Pérez, M.A., Marconi, E. (Eds.) Book of End of WoodMusICK COST Action FP1302, 67–80.

OR16

Pedoanthracological records as tools for revelation of the forest history in the Khan Khentii Mts., northern Mongolia

Novák, Jan[1]; Kusbach, Antonín[2]; Abrahám, Vojtěch; Štěrba, Tadeáš[3]

[1]Charles University in Prague
[2]Mendel University in Brno
[3]Forest Management Institute
Correspondence: kusbach@seznam.cz

Keywords: pedoanthracology, anthracomass, north Mongolia, altitude gradient, human impact

Human activities, fire, and climatic conditions strongly affected boreal forests during the Holocene period. We would like to reveal the importance of these environmental variables on the forest history using the pedoanthracological approach. Our pedoanthracological study was performed according to the altitude gradient (760 up to 1650 m asl) in Khan Khentii Mts. (northern Mongolia), where we have excavated 18 soil profiles.

Our results documented a significant corellation between level of anthracomass and position of soil profiles along to the altitude gradient. The Pinus forest-steppe region on the foothills was characteristic by a low anthracomass, while the frequency of fire events was relatively high. On the other hand, the soil profiles of high altitudes have burned less frequently, but the highest values of the anthracomass were recorded there. The character of charcoal records in the middle altitudes was significantly influenced by a human impact. The forest vegetation on the edge of the mountain range has been much more influenced by human activities than vegetation in the central area.

Acknowledgement

The contribution was supported by a project grant of the Czech Development Agency: Development of Forests and the Gene Pool of Local Forest Tree Ecotypes in Mongolia 2015-18, CzDA-RO-MN-2014-6-31210 realized by the Forest Management Institute, Brandýs nad Labem, Czech Republic.

State-of-the-art multiscale X-ray CT scanning of increment cores

Van den Bulcke, Jan[1]; Boone, Marijn A.[2]; Van Loo, Denis[2]; Van Hoorebeke, Luc[3]; Boone, Matthieu N.[3]; Beeckman, Hans[4]; Van Acker, Joris[1]; De Mil, Tom[1]

[1]Ghent University, Department of Environment, UGCT – UGent-Woodlab / Laboratory of Wood Technology, B-9000 Gent, Belgium
[2]TESCAN XRE, Bollebergen 2B box 1, B-9052 Gent, Belgium
[3]Ghent University, Department of Physics and Astronomy, UGCT – Radiation Physics Research Group, Proeftuinstraat 86/N12, B-9000 Gent, Belgium
[4]Royal Museum for Central Africa, Wood Biology Service, Leuvensesteenweg 13, B-3080 Tervuren, Belgium
Correspondence: Jan.VandenBulcke@UGent.be

Keywords: X-ray CT scanning, multiscale, increment cores

X-ray CT scanning has become an important 3D microscopy technique. It is a potential game-changer for tree-ring research, given that not only Maximum Latewood Density (MXD) and tree-ring width series can be measured, but sub-annual density series can be acquired as well (Van den Bulcke et al. 2014). Furthermore, when scanning at higher resolutions, wood anatomical measurements are within reach. Existing X-ray CT systems offer tremendous potential for scanning tree cores at multiple spatial scales. We illustrate the scanning of tree increment cores of a set of wood species (*Pinus sylvestris*, *Quercus* spp, *Fagus sylvatica* and *Betula pendula*) at the UGCT (UGent Centre for X-ray Tomography) and TESCAN (formerly XRE, spin-off company of UGCT). Voxel pitch (~resolution) ranges from several tens of microns down to a few micron without sample preparation. We make use of the same sample holders as explained in De Mil et al. (2016) for high-throughput scanning. Depending on the spatial scale, several meters of tree cores can be scanned simultaneously at resolutions of approximately 60 micron. Specific VOI (Volume of Interest) scanning even enables scanning of single increment cores without removal from the sample holder. Finally, focusing on single tree-core scanning in a dedicated sample holder at a resolution down to a few microns delivers high anatomical detail (e.g. vessel anatomy). Current and future developments in scanner optimization and scanner protocols heralds a new era for tree-ring research.

References

Van den Bulcke, J., Wernersson, E.L., Dierick, M., Van Loo, D., Masschaele, B., Brabant, L., Boone, M.N., Van Hoorebeke, L., Haneca, K., Brun, A., Hendriks, C.L.L., Van Acker, J., 2014. 3D tree-ring analysis using helical X-ray tomography. Dendrochronologia 32, 39–46.

De Mil, T., Vannoppen, A., Beeckman, H., Van Acker, J. and Van den Bulcke, J., 2016. A field-to-desktop toolchain for X-ray CT densitometry enables tree ring analysis. Annals of botany 117, 1187–1196.

Acknowledgement

We would like to thank Stijn Willen for his help with the preparation of sample holders and samples.

OR18

X-ray CT analysis of wood formation: development and perspectives

Lehnebach, Romain[1,2]; Campioli, Matteo[3]; Van Acker, Joris[1,2]; Van den Bulcke, Jan[1,2]

[1]Ghent University, Department of Environment, UGent-Woodlab / Laboratory of Wood Technology, B-9000 Gent, Belgium.
[2]Ghent University Centre for X-ray Tomography (UGCT), Proeftuinstraat 86, B-9000 Gent, Belgium.
[3]Centre of Excellence PLECO (Plant and Vegetation Ecology), Department of Biology, University of Antwerp, 2610 Wilrijk, Belgium.
Correspondence: romain.lehnebach@ugent.be

Keywords: wood formation, x-ray computed tomography, cambium, wood phenology

Conventional methods for the study of xylogenesis are time-consuming and imply the use of specific tools as well as trained operators to produce high-quality anatomical slices. Independently from the technical requirements inherent to wood formation study, the need for a better assessment of the intra-annual carbon storage in trees involves the integration of different plant parts and covering large geographical areas, stressing the need to process a large number of samples in a relatively short period. To face this challenge, more efficient methods must be developed. High-resolution X-ray Computed Tomography (XµCT) is becoming popular in the analysis and imaging of wood. Here, we tested the applicability of XµCT in the context of xylogenesis study.
Microcores of 3 species (*Pinus nigra*, *Fagus sylvatica* and *Quercus robur*) growing close to Antwerp, Belgium, were collected during the growing season 2019 and XµCT scanned with the Nanowood scanner developed at the Centre for X-ray Tomography of the Ghent University (UGCT). Prior to scanning, the microcores were dried using critical point drying in order to achieve a sufficient contrast while preserving the tissue structure.
Micron-level scanning allowed a rapid assessment of cambial activity and thickness of the newly formed growth ring. Sub-micron scanning provided high-quality images of the cambial region and its derivatives, allowing the development of morphometric analysis. Although the approach presented here needs improvement and optimization, XµCT is a promising way for the study of wood formation.

Acknowledgement

We would like to thank Sebastien Leys, Inge Dox and Bertold Mariën for the field sampling and Stijn Willen for manufacturing the sample holders.

OR19

Measuring and editing tree rings in ImageJ using the plugin TreeRingJ

García-González, Ignacio[1]

[1]*Universidade de Santiago de Compostela, Departamento de Botánica, EPSE, Campus Terra, Lugo, 27002 Spain*
Correspondence: ignacio.garcia@usc.es

Keywords: image analysis, tree-ring measurements, ImageJ

ImageJ is an open image analysis software that has been used for the last couple of decades in many scientific disciplines, as it allows performing manual and automatic measurements of multiple objects. It is a multi-platform program written in Java, and can be easily extended by writing new plugins.
In this work, the final version of TreeRingJ is presented. This piece of software is a powerful plugin that has been implemented for ImageJ, with the aim of measuring tree rings from images taken of wood surfaces, and also editing and correcting measurements, adding specific information, or exporting ring width into several format for further processing. Initially, TreeRingJ allows manual tracing of tree rings (total ring width and earlywood-latewood widths), markings and text annotations, which can be saved as regions-of-interest (ROIs) of ImageJ. These objects can later be retrieved, and corrected when necessary, before obtaining the final values in the most common dendrochronological formats.
TreeRingJ has been designed to be a simple and straightforward tool for manual measuring and editing. However, the objects that represent tree rings in this plugin can be easily created from ImageJ, which permits its full compatibility with other potential plugins for automatic tree-ring measurements, whose results will be easily imported and further edited into TreeRingJ.

OR20

Spatio-temporal dynamics of the upper tree line in the polar Urals: centuries-old downward and upward shift

Mikhailovich, Anna P.[1]; Fomin, Valery V.[2]; Shiyatov, Stepan G.[3]

[1]Department of Physical Methods and Devices for Quality Control, Ural Federal University, Yekaterinburg, the Russian Federation
[2]GIS-technologies Research Laboratory in Ecology and Forest Sciences, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation
[3]Laboratory of Dendrochronology, Institute of Plant and Animal Ecology, the Russian Federation
Correspondence: fomval@gmail.com

Keywords: upper tree line ecotone, distribution of trees, spatio-temporal dynamics, Polar Urals, Larix sibirica Ledeb

A ground-based mapping of the location of trees (*Larix sibirica* Ledeb) growing in the upper tree line ecotone and died during the Little Ice Age on the southeastern macroslope of the Rai-Iz mountain massif (Polar Urals, Russia) was implemented. According to the pattern recognition of aerial and satellite images of high spatial resolution taken in the 1960s, 1980s, 2000s and 2010s the location of trees with the height more than 4–6 meters in the study area was defined. Over the past 50 years, the number of trees in the study area has doubled. Repeated landscape photographs taken from the same photographic points in the 1960s and 2010s also indicate the expansion of woody vegetation into the tundra. At the same time, it has been established that modern trees, as a whole, have not reached the parts of the region yet where they grew in the past. Using the original method of determining the boundaries between the main types of phytocenohoras (closed, open and light forests as well as the tundra with single trees), the maps that characterize the distribution of phytocenochoras in the study area in the second half of the 20th and early 21st centuries were created. We found a 15 percent increase in the areas of closed, open and light forests due to reducing the areas of tundra with single trees.

Acknowledgement

This work was supported by the Russian Foundation for Basic Research (Grant No. 18-34-00803 mol_a).

OR21

A synoptic view on intra-annual density fluctuations

Mayer, Konrad[1]; Grabner, Michael[1]; Felhofer, Martin[2]; Gierlinger, Notburga[2]

[1]University of Natural Resources and Life Sciences (BOKU), Institute of Wood Technology and Renewable Materials, Konrad-Lorenz-Straße 24, 3430 Tulln an der Donau, Austria
[2]University of Natural Resources and Life Sciences (BOKU), Institute of Biophysics Muthgasse 11/II 1190 Vienna, Austria
Correspondence: konrad.mayer@boku.ac.at

Keywords: intra-annual density fluctuation, Raman spectroscopy, wood anatomy, x-ray densitometry

Tree growth, as an archive of environmental conditions, has proven to provide valuable proxies for climate reconstruction as well as the assessment of growth-climate relationships. Density measurements were successfully used in the field of dendroclimatology in the past with recent efforts to obtain sub-annual predictors from density profiles used in various modeling approaches. Particular attention is laid on intra-annual density fluctuations in this regard. However, while used in seasonal or event-related modeling frameworks, their formation and function as well as link to other chemical and anatomical characteristics is not well understood.

In our ongoing study we address the latter point by investigating radial intra-annual trends of chemical and anatomical characteristics, such as cellulose to lignin ratio, micro-fibrillar angle, tracheid length as well as size and frequency of pits. Measurements were done on specimen of silver fir alongside their density profiles, leading to a synoptic view of profiles of multiple features. These profiles range from the annual ring formed in 2004 to the annual ring formed in 2006 including a pronounced intra-annual density fluctuation in the year 2005. Preliminary results derived from Raman spectroscopy indicate that other wood characteristics are affected as well, whenever a fluctuation in density appears. However, further implications regarding timing at xylogenesis have yet to be considered.

References

Battipaglia, G., Campelo, F., Vieira, J., Grabner, M. et al., 2016. Structure and function of intra-annual density fluctuations: Mind the gaps. Frontiers in Plant Science 7, 595.

Schweingruber, F.H., Fritts, H.C., Bräker, O.U., Drew, L.G., Schär, E., 1978. The x-ray technique as applied to dendroclimatology. Tree-Ring Bulletin 38, 61–91.

OR22

Can we chop a tree-ring into time-slices? What wood formation dynamics can bring to intra-annual tree-ring sciences.

Pérez-de-Lis, Gonzalo[1]; Rathgeber, Cyrille B. K.;[1] Ponton, Stéphane[1]

[1]Université de Lorraine, AgroParisTech, INRA, UMR Silva, 54000 Nancy, France
Correspondence: gonzalo.perezdelis@inra.fr

Keywords: conifer, seasonal pattern, tracheid, tree-ring sectoring, xylogenesis

Tree-ring records can potentially provide information on tree responses to environmental conditions at very short-term scales (Babst et al. 2017). The study of intra-ring characteristics generally implies splitting the ring into a variable number of sectors that are assumed to be formed in successive discrete time intervals (Szejner et al. 2018). However, to which extent this assumption respects the nature of the mechanisms involved in wood formation is largely unknown.

In order to relate intra-ring sectoring to key wood formation processes (cell enlargement and wall thickening), we used a three-year xylogenesis data survey for three conifer species growing under temperate conditions in northeastern France (Cuny et al. 2016). We analyzed changes in (1) time window length, (2) time overlapping, and (3) within-stand synchronicity of xylogenesis processes in ten regular tree-ring sectors.

The time required by each sector to be formed increased along the growing season because of the higher number of tracheids per unit area and the longer cell wall thickening periods in latewood. Daily variation in the amount of forming sectors peaked in May-June, revealing that formation in 30–40% of the ring sectors was simultaneous during that period. Trees synchronized their growth for the first sectors, whereas time lags among individuals gradually increased throughout the ring, particularly during enlargement.

Our results indicate that intra-ring sectors cannot be dated by solely using their position in the ring. Thus, a deeper knowledge of the dynamics of wood formation is crucial to extract seasonal information from tree rings.

References

Babst, F., Poulter, B., Bodesheim, P., Mahecha, M.D., Frank, D.C., 2017. Improved tree-ring archives will support earth-system science. Nature Ecology & Evolution 1, 0008.

Cuny, H.E., Rathgeber, C.B.K., 2016. Xylogenesis: Coniferous Trees of Temperate Forests Are Listening to the Climate Tale during the Growing Season But Only Remember the Last Words! Plant Physiology 171, 306–17.

Szejner, P., Wright, W.E., Belmecheri, S., Meko, D., Leavitt, S.W., Ehleringer, J.R., Monson, R.K., 2018. Disentangling seasonal and interannual legacies from inferred patterns of forest water and carbon cycling using tree-ring stable isotopes. Global Change Biology 24, 5332–5347.

Acknowledgement

We thank E. Cornu, E. Farré, C. Freyburger, P. Gelhaye, and A. Mercanti for fieldwork, and M. Harroué for micro-section preparation. We also thank H. Cuny, who performed cell counts and firstly analyzed xylogenesis data during his PhD studies. This work was supported by a grant overseen by the French National Research Agency (ANR) as part of the „Investissements d'Avenir" program (ANR-11-LABX-0002-01, Lab of Excellence ARBRE).

OR23

Differing effects of two consecutive extreme years on radial growth of pines along an elevation gradient on Corsica

Häusser, Martin[1]; Szymczak, Sonja[1]; Garel, Emilie[2]; Huneau, Frédéric[2]; Santoni, Sébastien[2]; Bräuning, Achim[3]

[1]Friedrich-Alexander University Erlangen-Nürnberg, Institute of Geography, Wetterkreuz 15, 91058 Erlangen, Germany
[2]University of Corsica Pascal Paoli, Laboratory of Hydrology, 22 Ave. Jean Nicoli, 20250 Corte, France
[3]Friedrich-Alexander University Erlangen-Nürnberg, Institute of Geography, Wetterkreuz 15, 91058 Erlangen, Germany
Correspondence: martin.haeusser@fau.de

Keywords: Pinus pinaster, Pinus nigra ssp. laricio, dendrometer, wood anatomy, Corsica

The ongoing climate change in the western Mediterranean basin evinces more pronounced drought periods in the growing season. The mountainous island of Corsica, France, experienced two climatological very interesting consecutive years: 2017 was remarkably dry and posed a record minimum in annual precipitation. In contrast, 2018 was an especially wet year with a summer precipitation more than twofold of the long-term average. Both years were equally warm, as they rank the second and third warmest summers since 1900 for entire France. The impact of these two climatically outstanding years on native trees was recorded on five study sites, ranging from sea-level up to 1600 m asl. Forty-two pines, spanning the island along an E-W transect, were equipped with electric band dendrometers and microcore samples were taken in a biweekly interval. Maritime pine (*Pinus pinaster*) grows in low regions whereas Corsican Black pine (*Pinus nigra* ssp. *laricio*) populates high elevations. First results of this analysis show significant differences in length of the growing period as well as varying impacts on radial growth in different elevation belts. During the summer drought of 2017, the two coastal sites showed stagnation or even shrinkage of tree circumferences. The annual maximum circumference was more affected in the western part of the transect than the east and the higher sites were less impacted than the lower ones. In contrast, all sites exhibited continuous growth over the summer months in 2018 with later onset of latewood formation by almost a month across the island.

OR24

Modelling intra-annual growth dynamics of Picea abies in treeline

Tumajer, Jan[1]; Kašpar, Jakub[2]; Kuželová, Hana[1]; Treml, Václav[1]

[1]Charles University, Faculty of Science, Depertment of Physical gepgraphy and Geoecology, Albertov 6, 12843 Prague, Czech Republic
[2]The Silva Tarouca Research Institute for Landscape & Ornamental Gardening, Department of Forest Ecology, Lidicka 25–27, 60200 Brno, Czech Republic
Correspondence: tumajerj@natur.cuni.cz; tumajer1@email.cz

Keywords: Vaganov-Shashkin, xylogenesis, process-based modelling, intra-annual growth dynamics, treeline

Temperate and boreal forests are recently facing unprecedented climate and environmental changes together with higher frequency and intensity of extreme climatic events. The environmental and socio-economic importance of forests increases the need for our understanding of their growth on all spatial (from tissues to ecosystems) and temporal (from intra-annual to multi-centennial) scales. However, studies on the long-term (decades to centuries) changes of inter-annual growth dynamics are rare due to the lack of sites with long observations (e.g., using dendrometers or xylogenesis monitoring). Although climatically-driven process-based models (e.g., Vaganov-Shashkin) are capable to reconstruct past changes in the timing of cambial activity, their use in such a manner is limited by the lack of data on intra-annual growth dynamics applicable for verification.

To address those issues, we used 8 years of xylogenesis monitoring of *Picea abies* situated to the treeline of the Giant Mountains (N Czech Republic) to verify cambial activity timing (dates of onset, culmination and termination, duration of specific phases) and dynamics (daily integral growth rates) estimated by Vaganov-Shashkin process-based model. Eight years of verification enables identification of possible systematic biases and definition of correction factors, which, subsequently, are applied to model outputs in the pre-calibration period to obtain long chronologies of key dates of cambial activity (e.g., onset and termination). Finally, those chronologies are treated using traditional dendroclimatological statistics (correlation analysis) to identify climatic factors responsible for recent shifts in growing season timing and duration.

Acknowledgement

This research was supporten by the Czech Science Foundation (19-13807S).

OR25

The impact of horse-chestnut leaf miner on cambial activity and differentiation of secondary conductive tissues of horse-chestnut

Myśkow, Elżbieta[1]; Sokołowska, Katarzyna[1]; Słupianek, Aleksandra[1]; Gryc, Vladimir[2]

[1]University of Wrocław, Institute of Experimental Biology, Kanonia 6/8, 50-328 Wrocław, Poland
[2]Mendel University in Brno, Faculty of Forestry and Wood Technology, Dep. of Wood Science, Zemědělská 3, 61300 Brno, Czech Republic
Correspondence: elzbieta.myskow@uwr.edu.pl

Keywords: Aesculus hippocastanum, Cameraria ohridella, cambial activity, secondary conductive tissues

In Europe, in last decades, the trees of horse-chestnut (*Aesculus hippocastanum*) are intensively attacked by a leaf miner *Cameraria ohridella*. The caterpillars feed on the mesophyll inside the leaves. The effect of the pest invasion is directly visible as the leaf drying and falling down, but it also results in the modification of the photosynthesis effectiveness and formation of fruits. However, the impact of the *Cameraria* on growth and development of trees is still unknown. Therefore, the aim of our study was to analyse *Cameraria* influence on cambial activity and differentiation of the secondary conductive tissues in *Aesculus trees*. We studied nine intensively attacked trees and six trees with a significantly lower degree of leaf damage in Wrocław, Poland. Cambial activity and production of derivative tissues were analyzed on transverse sections prepared from microcores, taken with the use of the Trephor tool during two growing seasons; the anatomical data was further correlated with phenological observations. The first cambial divisions were observed in mid-April, then they intensified in mid-May, after flowering and the formation of first xylem elements. Interestingly, more damaged trees showed shorter cambial activity (to mid-July) than less affected trees. In addition, in the affected trees, thinner annual rings were formed, with reduced mechanical wood properties. We suggest that protective treatments, like removal of leaves in autumn, significantly improve the condition of the trees and quality and quantity of the secondary tissues formed.

Acknowledgement

The research was supported by the Provincial Found for Environmental and Water Management in Wrocław, Poland.

OR26

Tree water status fluctuations directly affecting the xylem cell morphogenesis of drought-stressed Scots pine trees

Fajstavr, Marek[1]; Horáček, Petr[1]; Giagli, Kyriaki[2]; Vavrčík, Hanuš[2]; Gryc, Vladimír[2]; Stojanović, Marko[1]; Urban, Josef[3]

[1]Department of xylogenesis and biomass allocation, Domain of environmental effects on terrestrial ecosystems, Czechglobe – Global Change Research Institute, The Czech Academy of Sciences, Belidla 4a, 60300 Brno, Czech Republic.
[2]Department of Wood Science, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemedelska 3, 61300 Brno, Czech Republic.
[3]Department of Forest Botany, Dendrology and Geobiocenology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemedelska 3, 61300 Brno, Czech Republic. Siberian Federal University, Svobodnyj Prospect 79, Krasnoyarsk, 660041 Krasnoyarsk,
Correspondence: fajstavr.m@czechglobe.cz

Keywords: Pinus sylvestris, morphogenesis, tracheid, water status, drought

Major current problem in the terrestrial temperate forests is the long-lasting drought periods combined with heat waves negatively affecting the tree water status. Very few information still exists on the acclimation processes of drought-suffering Scots pine trees. We analysed the morphogenesis rate of differentiating tracheids during summer drought for three consecutive growing seasons (2014–2016). Xylem tissues were micro-cored (Trephor tool) from the tree stems in weekly intervals. The microcore samples were used for preparing permanent microscopic slides (cross sections) to analyse the cambial activity, duration and rate of tracheid morphogenesis. During all examined years, we recorded summer drought episodes, where the value of the daily soil water potential dropped below –1 MPa and daily sap flow dropped under 5 kg·day^{-1}, resulting to cambial latency (reduced number of dividing cells). After improved tree water status the cambial division was reactivated and hence, the xylem cells began to form again. This resulted to formation of earlywood-like tracheids appearing inside the latewood zone (intra-annual density fluctuation) reflected also by the rate of cell enlargement and cell-wall thickening. The longest and most severe summer drought period in 2015 ceased the cambial activity significant earlier (in mid-August) and the latewood tracheids spent significant shorter time in both cell enlargement and cell wall thickening phases which resulted to 32% narrower tracheids with 34% thinner cell walls compared with the other years. Thus we concluded that the fluctuations of tree water status had a direct impact on the cell radial dimensions and mainly, cell-wall thickness.

References

Fajstavr, M., Giagli, K., Vavrčík, H., Gryc, V., Urban, J. 2017. The effect of stem girdling on xylem and phloem formation in Scots pine. Silva Fennica 51, article id 1760.

Fajstavr, M., Paschová, Z., Giagli, K., Vavrčík, H., Gryc, V., Urban, J. 2018. Auxin (IAA) and soluble carbohydrate seasonal dynamics monitored during xylogenesis and phloemogenesis in Scots pine. IForest – Biogeosciences For. 11, 553–562.

Acknowledgement

This experimental research was supported by the Internal Grand Agency of Faculty of Forestry and Wood Technology (IGA, 42/2014 and IGA LDF, LDF_VP_2016014), European Social Fund and the state budget of the Czech Republic CzechGlobe – Global Change Research Institute of the Czech Academy of Sciences (GCRI). This work was supported by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415 and by the Russian Science Foundation [Project 18-74-10048,The anatomical and physiological response of Scots pine xylem formation to variable water availability'].

OR27

The effect of water manipulation on xylogenesis: adjusting rates rather than duration

Vieira, Joana[1]; Carvalho, Ana[1]; Campelo, Filipe[1]

[1]Centre for Functional Ecology – Science for the People & the Planet, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal
Correspondence: joana.vieira@uc.pt

Keywords: cambial activity, irrigation, tracheids, water exclusion, wood formation

Tree growth is one of the most studied aspects of tree biology, particularly secondary growth. The activity of the vascular cambium is determined by intrinsic and extrinsic factors such as temperature and water availability. Both factors combined determine the duration of cambial activity and rate of cell production. In the Mediterranean region cambial activity is mostly determined by water availability. Climate projections for the region predict drier springs and wetter autumns. Understanding the effect of climate change on tree growth is crucial to adjust forest practices in order to mitigate its impact. In 2017, we simulated a spring drought and a wet autumn in a *Pinus pinaster* Aiton forest stand to investigate how cambial activity and wood production is affected under the predicted scenarios of climate change. Eighteen trees were divided into 3 groups: control, rain exclusion and irrigation. Spring drought was simulated by installing a continuous plastic sheet on the forest floor from February 27th to October 1st. The irrigation treatment was carried out in September and consisted of providing an extra 1200L of water per tree (8 applications in 4 weeks). Cambial activity and wood formation was monitored every 10 days by collecting microcores using a Trephor. Spring drought had no effect on the duration of xylogenesis but decreased the rate of cell production. The extra irrigation in September triggered a second period of cambial activity during which tracheids with wider lumen diameter were formed.

Acknowledgement

This study was supported by the Fundação para a Ciência e a Tecnologia, Ministério da Educação e Ciência (FCT) co-financed by Compete, through the project PTDC/AAG-GLO/4784/2014.

OR28

Temperature rather than precipitation limits vessel features in earlywood and radial growth of Manchurian ash (Fraxinus mandshurica Rupr.) in temperate forests

Zhu, Liangjun[1]; Cooper, David J.[2]; Li, Zongshan[3]; Zhang, Yuandong[4]; Liang, Hanxue[5]; Wang, Xiaochun[1]

[1]School of Forestry, Northeast Forestry University, 26 Hexing Road, Harbin 150040, China
[2]Department of Forest and Rangeland Stewardship, Colorado State University, Fort Collins, CO 80523, USA
[3]State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China
[4]Key Laboratory of Forest Ecology and Environment, State Forestry Administration, Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Beijing 100091, China.
[5]South China Botanical Garden, Chinese Academy of Sciences, Guangzhou 510650, China
Correspondence: wangx@nefu.edu.cn

Keywords: temperate forest, temperature limitation, xylem anatomy, earlywood vessel, tree rings

Earlywood vessels of a ring-porous broad-leaved tree species play a major role in water dredging. Then, is moisture the main factor affecting earlywood vessel (EWV) traits? Manchurian ash (*Fraxinus mandshurica* Rupr.) is one of the most important ring-porous broad-leaved tree species in temperate forests of China. To evaluate the relationships between vessel traits and radial growth and their climatic constraints, we investigated the EWV traits and radial growth of Manchurian ash from a network of 19 sites across the temperate broadleaved-Korean pine mixed forests in Northeast China. Results showed that a slight downward trend in ring width (RW) and vessel number (VN) and an obvious upward trend in vessel density (VD), hydraulic diameter (Dh) and mean vessel area (MVA) of EVs occurred 50 years ago in cambium age, and then significantly reduced or disappeared. The VD significantly negatively correlated with RW, while the other EWV parameters reflected the tradeoff between hydraulic efficiency and safety. There were significant positive correlations between RW and VN and MVA at most sites, as well as between MVA and VN. It indicated that Manchurian ash maximizes wood production by increasing MVA and VN under favorable growth conditions. The positive correlation between RW and total vessel area (TVA) and VN was stronger than that of MVA, which indicated that RW and TVA are determined by VN rather than vessel size. Manchurian ash can adjust its characteristics of EWV according to site, climate and tree age. Temperature, especially the minimum temperature in the previous growing season (PGS) and current summer, was significantly negatively correlated with VD, but positively correlated with RW and other EWV parameters in almost all sites. In some of the more arid northern sites, all EWV parameters of Manchurian ash were affected relative humidity (Rh) of the PGS and precipitation (P) and standardized

precipitation-evapotranspiration index (SPEI) of the previous non-growing season (PNG). Therefore, temperature rather than water limits the EWV traits and radial growth of Manchurian ash, but the limitation of water in dry sites is significantly enhanced. The climatic signals recorded by RW and EWV characteristics were consistent in almost all sites. Water conduction (VN, Dh and MVA) and carbon allocation (RW) of Manchurian ash are positively correlated with temperature, which explains the potential physiological mechanisms of growth increase of Manchurian ash in temperate forests caused by climate warming. Drought stress may be the most critical limiting factor for vessel development and xylem formation of Manchurian ash in northern sites if climate warming continues or intensifies, and the effect of temperature may change from positive to negative.

OR29

Complex climate-growth relationships of ring-porous oaks are optimized by combining earlywood vessels and latewood width: some examples from northwestern Iberia

García-González, Ignacio[1]; Souto-Herrero, Manuel[1]

[1]Universidade de Santiago de Compostela, Departamento de Botánica, EPSE, Campus Terra, Lugo, 27002 Spain
Correspondence: ignacio.garcia@usc.es

Keywords: earlywood vessels, quantitative wood anatomy, latewood, Quercus robur, Quercus pyrenaica

'Classical' dendrochronology usually relies on the 'Principle of Limiting Factors', whereby a prevailing climatic constraint limits growth in most years, which is recorded by a growth parameter, usually tree-ring width. However, this is often not the case in mesic or oceanic areas of the world, where a clearly limiting climatic factor lacks, and different variables can influence tree growth depending on the year. In such cases, anatomical traits, as the size of the earlywood vessels of ring-porous trees, have often been proposed as proxies to establish climate-growth relationships.

In this work, we show some examples on how the influence of climate upon growth can be identified for two ring-porous oak species (*Quercus robur* and *Q. pyrenaica*) growing close to their distribution boundary in the northwestern Iberian Peninsula. Using a network of chronologies all over the regions, we show that only when analyzing earlywood anatomy and latewood increment separately, can the prevailing climate-growth relations be correctly identified. Furthermore, earlywood vessel size is closely related to conditions during the dormant period or early spring, whereas latewood width responds to factors that drive productivity during late spring and summer. However, latewood productions is highly influenced by forest disturbances or management, contrarily to earlywood anatomical traits, which are mainly linked to climate.

Our results are also consistent with studies of wood formation in the region, and demonstrate the need of analyzing earlywood and latewood of oaks separately, as well as the importance of involving chronologies of earlywood vessel features.

OR30

Time lag between stem radial increment and stem carbon allocation and its consequences to net ecosystem production

Krejza, Jan[1,2]; Světlík, Jan[1,2]; Nezval, Ondřej[1,2]; Foltýnová, Lenka[1]; Horáček, Petr[1]

[1]Global Change Research Institute CAS, Bělidla 986/4a, 603 00, Brno, Czech Republic
[2]Department of Forest Ecology, Faculty of Forestry and Wood technology, Mendel University in Brno, Zemědělská 3, 613 00
Correspondence: krejza.j@czechglobe.cz

Keywords: carbon balance, stem radial increment, drought stress, carbon flux, dendrometers record

Automatic dendrometers are an efficient tool for field measurement since their measurements comprise information of stem growth and water stress reaction. The study is primarily focused on the comparison of eddy-covariance measurement of net ecosystem production (NEP) with the carbon sequestration into stem woody tissues as measured with dendrometers – stem carbon allocation (SCA). Stem radial increment (SRI) measurements, wood cell anatomy and carbon fluxes with microclimatic measurements were performed at the study site of Rájec (the Drahanská vrchovina Highland, Czech Republic) from 2012 to 2017. SCA calculation was based on the combination of continuous SRI record, changing wood cell anatomy within the growing season and forest inventory data. Time lag (about 32 day) was found between the culmination of SRI and SCA because the secondary cell wall thickening was confirmed as the main driving factor of SCA. Mean SCA contributed 34 % to NEP, with significant differences in dry (16 %) and wet (45 %) growing season of wood cell. The climate response of SRI, SCA and NEP were assessed over the study period. Positive correlation coefficients were found between Standardized Precipitation and Evaporation Index (SPEI) and SRI (June–Oct), SCA (June–Dec) and NEP (Mar–Dec). Results indicated that SCA is as very sensitive parameter to drought, because the maximum rate of SCA has been observed during heat waves or drought period occurring within the growing season. The continuous dendrometer records can be used as an efficient tool for the biomonitoring of drought stress.

Acknowledgement

This work was supported by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415 and by grant number TJ01000309 of the Technological Agency of the Czech Republic.

OR31

Inter-individual variability in spring phenology of late successional temperate deciduous trees is determined by tree growth characteristics and previous year autumn phenology

Marchand, Lorène Julia[1]; Dox, Inge[2]; Leys, Sebastien[2]; Gričar, Jožica[3]; Prislan, Peter[3]; Van den Bulcke, Jan[4]; Campioli, Matteo[5]

[1]Université de Rennes, CNRS, UMR ECOBIO 6553, Av du Général Leclerc, 35042 Rennes, France
[2]University of Antwerp, Department of Biology, Centre of Excellence Plants and Ecosystems (PLECO), Universiteitsplein 1, 2610 Wilrijk, Belgium
[3]Slovenian Forestry Institute, Department of Yield and Silviculture, Vecna pot 2, 1000 Ljubljana, Slovenia
[4]Gent University, Faculty of Bioscience Engineering, Laboratory of Wood Technology – Woodlab, Coupure Links 653, 9000 Ghent, Belgium
[5]University of Antwerp, Department of Biology, Centre of Excellence Plants and Ecosystems (PLECO), Universiteitsplein 1, 2610 Wilrijk, Belgium
Correspondence: matteo.campioli@uantwerpen.be

Keywords: spring, leaf phenology, xylogenesis, temperate deciduous trees

We investigated the inter-tree variability of leaf- and wood spring phenology of temperate deciduous species and its possible drivers. Up to day, this topic has been largely overlooked and we do not know why mature individuals in the same stands show different timing of spring reactivation. Such knowledge is however of fundamental importance to understand tree functioning, structure of forest understory and modelling of single tree and stand dynamics. Here, bud-burst, cambium reactivation and full differentiation of first earlywood vessels were monitored from the summer of 2017 until the summer of 2018 in pedunculate oak, European beech and silver birch at two forest sites in Belgium. Inter-tree variability was larger for cambium reactivation and full differentiation of initial earlywood vessels than for bud-burst and varied across species and stands. The inter-tree variability of spring phenology was primarily correlated to previous autumn phenophases (i.e. the onset of leaf senescence and the cessation of wood formation) and to tree dendrometric characteristics (i.e. age and height) for oak and beech, but not for birch whose inter-tree variability could not be related to any growth or phenological variables. Linear models could explain 60–80% of inter-tree variability of spring phenology using a few tree growth traits and previous year autumn phenology. In particular, tree diameter and previous autumn leaf and wood phenology explained 70% of the inter-tree variability in bud-bursting, without including any specific site effect. These findings represent a major advance in the fundamental understanding of tree individual variability in spring phenology.

OR32

New insights on autumn phenology of temperate deciduous trees: comparison of cessation of woody growth and onset of foliar senescence in autumn in the European beech and the silver birch along their distributional range in Europe

Dox, Inge[1]; Gričar, Jožica[2]; Marchand, Lorène[3]; Leys, Sebastien[1]; Zuccarini, Poalo[4]; Geron, Charly[5]; Prislan, Peter[6]; Mariën, Bertold[1]; Fonti, Patrick[7]; Lange, Holger[8]; Peñuelas, Josep[4]; Van den Bulcke, Jan[9]; Campioli, Matteo[1]

[1]University of Antwerp, Faculty of Science, Plants and Ecosystems, Universiteitsplein 1, 2610 Wilrijk, Belgium
[2]Slovenian Forestry Institute, Department of Yield and Silviculture, Večna pot 2, 1000 Ljubljana, Slovenia
[3]Université de Rennes 1, l'Unité ECOBIO, Avenue du Général Leclerc, 35042 Rennes, France
[4]CREAF, Unitat d'Ecologia Global, 08193 Cerdanyola del Vallès, Spain
[5]University of Liège, Faculty of Agro-Bio Tech, Passage des Déportés 2, 5030 Gembloux, Belgium
[6]Slovenian Forestry Institute, Department of Forest Techniques and Economy, Večna pot 2, 1000 Ljubljana, Slovenia
[7]Swiss Federal Research Institute WSL, Dendro-Sciences Research Unit, Subunit of Palaeo-Ecology, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland
[8]Norwegian Institute of Bioeconomy Research, Division of Environment and Natural resources, Høgskoleveien 8, 1433 Ås, Norway
[9]University of Ghent, Faculty of Bioscience Engineering, Laboratory of Wood Technology, Coupure Links 653, 9000 Ghent, Belgium
Correspondence: inge.dox@uantwerpen.be

Keywords: autumn phenology, xylogenesis, foliar senescence, temperate deciduous trees, sink limitation

Cessation of xylem or woody growth and the onset of foliar senescence are key autumn phenological events in temperate deciduous trees. Their timing is fundamental for the development and survival of trees, ecosystem nutrient cycling and exchange of matter and energy between the biosphere and atmosphere. Difficulties in their determination, however, have hindered our understanding of phenological mechanisms at the end of the growing season. Here, we compare the timing of cessation of woody growth and onset of foliar senescence for a common European pioneer species, the silver birch, and late-successional species, the European beech, at different latitudes across their European distributions. Specifically, we tested whether foliar senescence started before, after or concurrently with cessation of woody growth. Foliar senescence started concurrently with cessation of woody growth for silver birch. In contrast, foliar senescence occurred about two weeks after cessation of woody growth for European beech. We provide evidence that foliar senescence is triggered when woody growth decreases in late summer, therefore suggesting a mechanism of sink limitation as a regulator of the timing of foliar senescence.

Acknowledgement

This research was funded by the ERC Starting Grant LEAF-FALL. We would also like to thank the institutions that gave permission to conduct research in the study areas: Agency for Nature and Forest of the Flemish Government (ANB), the Military Defense of Belgium, City of Brasschaat (Belgium), NMBU Norwegian University of Life Sciences (Norway), Natural Park and Biosphere Reserve of Montseny and Municipality of Vallfogona de Ripollès (Spain).

OR33

Does growing longer mean growing wider?

Bijak, Szymon[1]; Helama, Samuli[2]; Jagus, Jaak[3]; Läänelaid, Alar[3]; Sohar, Kristina[3]

[1]Warsaw University of Life Sciences – SGGW, Faculty of Forestry, Nowoursynowska 159, 02-776 Warszawa, Poland
[2]Natural Resources Institute Finland, Eteläranta 55, 96301 Rovaniemi, Finland
[3]Department of Geography, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia
Correspondence: szymon.bijak@wl.sggw.pl

Keywords: vegetation period, effective and active temperature, climate change, Picea abies, Quercus robur

Climate change, especially increase in temperature, influences tree phenology in the temperate zone. The date of onset or end, and, as a result, the length as well the intensity of the growing season changes making it a possibly important factor of tree growth. It has been reported that during the second half of the 20th century growing season extended by almost a week in the Baltic Sea region. We hypothesised that extension of favourable growth conditions may be beneficial for trees in terms of cambium activity and formation of wider tree rings. Moreover we assumed that this benefit may be species-specific. We used 11 *Quercus robur* and 11 *Picea abies* chronologies from Estonia to investigate the relationship between growing season variables and radial growth of trees. The analysed vegetation period parameters included its start and end dates and duration, as well as sums of effective and active temperatures, which were calculated using daily mean temperatures measured by the Estonian Weather Service at meteorological stations in Tallinn, Tartu and Vilsandi. All the analysed tree-ring width series were pre-whitened and the tree-ring indices were correlated with the growing season variables. We found no significant relationship between radial growth of analysed oaks and spruces and tested parameters of the growth period. Investigated trees did not benefited from either earlier onset, or later end of the vegetation season. No significant effect of longer growing period or higher effective or active temperatures was found either. Observed relationships were common for both analysed species.

OR34

Past climate from chronicles to trees and beyond

Dobrovolný, Petr[1]

[1]*Department of Geography, Faculty of Science, Masaryk University and Global Change Research Institute, CAS, Brno, Czech Republic*
Correspondence: dobro@sci.muni.cz

Keywords: historical climatology, dendroclimatology, climate reconstruction, hydrometeorological extremes

In the Czech Lands, there is a long tradition of past climate studies done mostly from the two main types of archives. While anthropogenic archives, including various types of documentary evidence, are used in historical climatology, natural archives are represented mostly with tree rings analyzed within dendroclimatology. As usual, both types of proxies and both disciplines have strong and weak features. The main aim of this contribution is to show several examples of cooperation of historical climatology and dendroclimatology. Main achievements in the field of quantitative climate reconstruction for the territory of the Czech Lands and typical features of temperature, precipitation/drought variability will be presented. It will be demonstrated how the methodology that has been gradually built up in the realm of the dendro-science was successfully adopted also in historical climatology. This fact significantly improved the quality of numerous reconstructions based on documentary evidence. On the other hand, long chronologies of various extremes well-documented in chronicles served for independent verification of these outstanding features in several tree-ring chronologies. The synergy of both disciplines and the need for future cooperation for a better understanding of past, present, and future climate is stressed.

OR35

Impact of climatic factors on the radial increment of hornbeam and grey alder at the borders of their ranges

Yermokhin, Maxim[1]; Mychko, Valyantsina[1]; Knysh, Natallia[1]; Lukin, Vitaliy[1]; Kurpatau, Alyksandr[1]; Komar, Sofiya[1]

[1]Institute of Experimental Botany, National Academy of Science of Belarus, Laboratory of Productivity & Stability of Plant Communities, Academicheskaya 27, 220072, Minsk, Belarus
Correspondence: yermaxim@yahoo.com

Keywords: Alnus incana, Carpinus betulus, ranges, climate, limiting factors

Borders of the ranges of three tree species cross the territory of Belarus: Norway spruce, grey alder and hornbeam. The main goal of our study was to estimate the changes at the range borders during the last 60 years, as well as to identify the main limiting climatic factors.

The boundaries of the ranges were identified based on the materials of the state forest inventory. Samples for dendrochronological studies were taken from hornbeam and grey alder trees located along their range borders in different parts of Belarus.

The hornbeam boundary has changed slightly. However, at a distance up to 10 km to the north, hornbeam occurs in the form of undergrowth or single trees of the secondary layer. The grey alder range, on the contrary, is reduced. In some regions, it shifted more than 50 km to the north compared with the border of the 1960s.

A high correlation of hornbeam increment with the December hydrothermal regime was established. One of the interesting facts is that all investigated hornbeam trees appeared in the 1940s. Most likely, its appearance and resettlement to the north began after the extremely cold winter of 1939– 1940, when air temperatures dropped below –40 °C.

In the tree-ring chronologies of the grey alder it is possible to note the high positive relationship between the increment and the precipitations of June and July in most chronologies. That is, the distribution of grey alder is mostly determined by summer droughts.

OR36

How coherent are stand-level tree growth trends and climate responses in conifer forests of Central Europe?

Treml, Václav[1]; Mašek, Jiří[1]; Tumajer, Jan[1]

[1]Charles University, Faculty of Science, Department of Physical Geography and Geoecology
Correspondence: treml@natur.cuni.cz

Keywords: individualistic growthe response, climate change, Pinus sylvestris, Picea abies

The tree growth responses to climatic variables and related growth trends may not be uniform at stand level. Possible deviations of tree growth from the driving climatic variable and changing growth coherency complicate predictions of forest reaction to ongoing warming. We tested the degree of individualistic tree growth response and changing climatic signal in tree rings of the major conifer ecosystems of Central Europe – lowland Scots pine forests and mountain Norway spruce forests. We further inspected possible factors leading to individualistic growth responses at stand level such as microsite relief, tree size, competition status and spatial autocorrelation.

Our results show that the growth coherency is greater, but more variable over time, in mountain Norway spruce compared to lowland Scots pine stands. The reason is mainly the greater age diversity in studied pine habitats and the impact of acid deposition in 1970–80s, which increased the growth coherency of Norway spruce stands. The common growth pattern (the first principal component) captured 60 % and 50 % of variance in Norway spruce and Scots pine growth trends, respectively. The tree size and spatial autocorrelation of growth patterns may account for about 9 to 15 % of growth variability. The reactions of trees to climate have changed over time. In spruce stands, the limiting effect of summer temperatures has been recently reduced, and a new negative response to drought has emerged. Pines have strengthened their response to drought. Overall, the changes in growth-climate responses were more pronounced in Norway spruce stands.

Acknowledgement

The study was supported by GAČR 19-13807S.

OR37

Climate sensitivity of narrow-leaved ash in floodplains

Trlin, Domagoj[1]; Mikac, Stjepan[1]; Žmegač, Anja[1]; Orešković, Marko[1]

[1]University of Zagreb, Faculty of Forestry, Department of Ecology and Silviculture, Svetošimunska 25, 10000 Zagreb, Croatia
Correspondence: dtrlin@sumfak.hr

Keywords: Fraxinus angustifolia, tree-ring chronology, floods and droughts, climate sensitivity

Tree-ring research on the treeline are common on high altitudes or north latitudes but not so in floodplains. Narrow-leaved ash (*Fraxinus angustifolia* Vahl) is growing in floodplain forests of Mediterannian region in mixture stands with pedunculate oak and in pure ash stands on the transition to the swamp. The aim of this research was to investigate a climate signal of pure narrow-leaved ash stands in Lonjsko polje Nature park in Croatia. The main characteristic of this area are spring and autumn floods but also summer droughts connected with heavy gley soil. Two tree-ring chronologies, both longer than 120 years, were considered and corelated with climate data (mean monthly air temperature-Temp, precipitation-Prec and standardized Palmer drought index – scPDSI) for 1901–2014 period and hydrological parameters (mean monthly water level-R and river discharge values-Q) for the Sava River in the 1926–2014 period. Correlation coefficients showed a strong positive correlation for Prec, R, Q and scPDSI in May, June, July and August of current year with greatest correlation for May-river discharge (r = 0.570) and also strong correlation for Aug-scPDSI (r = 0.533). Seasonal correlation coefficients were strongest for 4-month period for Aug-river discharge (r = 0.651) and Jul-precipitation (r = 0.623). This results showed that narrow-leaved ash could be used for long term reconstruction of climatic and hydrological fluctuations.

OR38

Drought limitation on tree growth at the Northern Hemisphere's highest tree line

Lyu, Lixin[1]; Zhang, Qi-Bin[1]; Pellattc, Marlow G.[2]; Büntgen, Ulf[3]; Li, Mai-He[4]; Cherubini, Paolo[4]

[1]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, China
[2]Parks Canada, Protected Areas Establishment and Conservation Directorate, Vancouver, British Columbia, V6B 6B4, Canada
[3]Department of Geography, University of Cambridge, CB23EN, Cambridge, UK
[4]Swiss Federal Research Institute WSL, Zürcherstrasse 111, CH-8903, Birmensdorf, Switzerland
Correspondence: qbzhang@ibcas.ac.cn

Keywords: Alpine tree line, drought stress, vegetation dynamics, growth-climate sensitivity, Tibetan plateau

The alpine tree line is generally assumed to be controlled by low temperatures, and thus to be experiencing an upward shift under global warming. As global temperatures rise, tree growth at the tree line could either increase if temperature is the limiting factor or decrease if a warming-induced loss of moisture limits growth. Here, we use dendrochronological techniques to understand the abiotic drivers of the Northern Hemisphere's highest tree line ecotones on the southern Tibetan Plateau (TP). Ring-width measurements from three juniper sites between 4680 and 4900m asl were significantly and negatively correlated with May–June–July evapotranspiration (ET0), and positively correlated with relative humidity and other oisture-related meteorological variables. At the same time, ring widths were negatively correlated with temperature means and sunshine rates. Our results highlight the common sensitivity of tree growth to moisture variations despite the differential growth trends occurring since 1850 (end of the Industrial Revolution) at the three tree line ecotones. These findings indicate that low temperatures may not be the sole driving force behind tree growth and the range dynamics of alpine tree lines. Tree lines in the dry parts of the TP and possibly also beyond are likely to retreat rather than to advance in a warmer world due to water limitations.

References

Liang, E., Dawadi, B., Pederson, N., Eckstein, D., 2014. Is the growth of birch at the upper timberline in the Himalayas limited by moisture or by temperature? Ecology 95, 2453–2465.
González de Andrés, E., Camarero, J.J., Büntgen, U., 2015. Complex climate constraints of upper treeline formation in the Pyrenees. Trees 29, 941–952.
Körner, C., 2012. Alpine Treelines-functional Ecology of the Global High Elevation Tree Limits. Springer, Basel, 220 pp.

Acknowledgement

This study was supported by the National Natural Science Foundation of China (Project No. 31330015 and No. 41771060) and by the Open Research Grant from Key Laboratory of Tibetan Environmental Changes and Land Surface Processes, Chinese Academy of Sciences and the China Scholarship Council (No. 201770490418). The climate data were obtained from the weather information center of China Meteorological Administration. We thank the three anonymous reviewers for their thoughtful and constructive comments on the manuscript, the Tibetan Forestry Bureau for field assistance, and our field team members for sample collection.

OR39

Climate sensitivity of black pine from mountainous coastal area in Croatia

Žmegač, Anja[1]; Mikac, Stjepan[1]; Trlin, Domagoj[1]; Orešković, Marko[1]

[1]University of Zagreb, Faculty of Forestry, Dep. of Forest Ecology and Silviculture, Svetošimunska cesta 23, 10000 Zagreb, Croatia
Correspondence: azmegac@sumfak.hr

Keywords: Black pine, climate sensitivity, tree rings

Black pine growing on Velebit mountain, which is a part of the Dinaric Alps, is a tertiary relict, covering a narrow area spanning a few kilometers in width and 20 km in length. It is located in Northeastern Mediterranean on the contact zone of the Mediterranean and continental climate, where no long-term instrumental measurements of climate are available. To assess how current temperature and precipitation fluctuations affect these areas in a long-term context, and to disentangle natural and anthropogenic effects on climate change, proxy evidence is necessary. Here, we aim to determine the effects of climatic factors using tree-ring widths of black pine (Pinus nigra J. F. Arnold) in the forest reserve Borovi vrh in Northern Velebit National Park (Croatia). We sampled 129 trees with the total of 257 cores ranging from 65 to 307 years. The cores were analyzed using standard dendrochronological approach, including core preparation by sanding, measuring with the ATRICS system and standardization. Correlation analysis revealed a significant and strong influence of summer precipitation of the current year on the radial growth of black pines. The results also point to the potential of these forests for climate reconstruction.

OR40

October–July precipitation reconstruction for Northern Kazakhstan since 1744

Akkemik, Ünal[1]; Köse, Nesibe[1]; Kopabayeva, Arailym[2]; Mazarzhanova, Kuralay[2]

[1]Istanbul University-Cerrahpasa. Forestry Faculty. Forest Botany Department. Bahçeköy – Istanbul/ Turkey
[2]S. Seyfullin Agroteknik University. Agromonia Faculty. Forest Resources and Forestry Department. Astana/Kazakhstan
Correspondence: nesibe@istanbul.edu.tr

Keywords: dendroclimatology, Pinus sylvestris, Burabai Region, tree ring

This study presents a precipitation reconstruction from previous October to current July for northern Kazakhstan. *Pinus sylvestris* forests in Burabai Region are quite important to collect samples to study the climate history. A regional chronology, covering the years of 1702–2014 was built by using 289/466 trees/cores. The gridded climate data for the years of 1950–2014 were used in calibration and verification process. Based on the positive and significant correlations between tree-ring indices and total precipitation from previous October to current July, we performed a reconstruction for the years of 1744–2014. The statistically significant R2, F, and ST and positive RE values were obtained for the calibration and verification periods. The reconstruction showed that 43 dry and 42 wet years occurred during the years of 1744–2014. The years of 1759–1762 were the longest consecutive drought since 1744, and the years of 1978–1981 were the longest consecutive wet years. We compared 21-year filtered precipitation reconstruction of this study to previous precipitation reconstruction from southeast Kazakhstan. We did not observed a similarity between their long-term trends. We also calculated spatial correlations between our reconstruction and the CRU TS 4.02 precipitation for the period of 1950–2014 to find out geographic agreement. Our reconstruction did not show an agreement with southern Kazakhstan, while the highest correlations were calculated for where the samples collected, Burabai Region, northern Kazakhstan and southern Russia. The reason of this weak correlation may arise from the different climate types in northern and southern of Kazakhstan.

Acknowledgement

This study was supported by S. Seyfullin Agroteknik University. We thank Director of Forest Service in Burabai Region for permission and the foresters for their helps in the field.

OR41

Climate reconstruction potential of pindrow fir tree rings from northwestern Himalaya

Malik, Rayees Ahmad[1]; Sukumar, Raman[1]

Indian Institute of Science, Centre for Ecological Sciences, Bangalore-560012, India.
Correspondence: rayeesmalik@iisc.ac.in

Keywords: Abies pindrow, climate change, northwestern Himalaya, climate reconstruction

Climate change has a significant impact on ecosystem dynamics and the social communities (Kahn, 2005; Webster, 2005). The Himalayan mountains are experiencing a higher warming than average global warming, which can significantly impact their biodiversity, vegetation distribution and ecosystem structure (Shrestha et al., 2012). Long-term records of climate are crucial to understand the recent climate change. In the Himalayan region, the instrumental climate records are relatively short. Tree rings offer an excellent proxy to extend the instrumental climate data. In this paper, we tested the climate reconstruction potential of ring-width chronologies of pindrow fir. The lower altitudinal site chronology showed stronger positive response to growing season precipitation and thus precipitation of Srinagar back to 1705 was reconstructed from this chronology. The reconstructed precipitation did not show any long-term trend. At centennial scale 20th century was the wettest period while as 19th century was the driest period. The precipitation reconstruction was able to capture some of the historically known events. Similarly, the highest altitudinal site chronology was used for reconstruction of past temperature of Srinagar because of its significant correlation with mean of June–July temperature of Srinagar. Though the reconstruction did not show any long-term trend but there are some decadal trends seen. On centennial scale, 20th century summer was hotter than other centuries in the reconstruction. These reconstructions added 196 and 312 years respectively to the instrumental climate data of Srinagar, Jammu and Kashmir. This study highlights the importance of Himalayan conifers in recording the variability in climatic factors.

References

Kahn, M.E., 2005. The Death Toll from Natural Disasters: The Role of Income, Geography, and Institutions. Rev. Econ. Stat. 87, 271–284.

Webster, P.J., 2005. Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment. Science (80–.). 309, 1844–1846.

Shrestha, U.B., Gautam, S., Bawa, K.S., 2012. Widespread Climate Change in the Himalayas and Associated Changes in Local Ecosystems. PLoS One 7, e36741.

OR42

A 424-year tree-ring based PDSI reconstruction of Deodar from Chitral HinduKush Range of Pakistan: linkages to the ocean oscillations

Sarir, Ahmad[1]; Zhu, Liangjun[1]; Yasmeen, Sumaira[1]; Zhang, Yuandong[2]; Li, Zongshan[3]; Ullah, Sami[4]; Wang, Xiaochun[1]

[1]Key Laboratory of Sustainable Forest Ecosystem Management-Ministry of Education, School of Forestry, Northeast Forestry University, Harbin 150040, China
[2]Key Laboratory of Forest Ecology and Environment, State Forestry Administration, Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Beijing 100091, China
[3]State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China
[4]Department of Forestry, Shaheed Benazir Bhutto University, Sheringal, Dir Upper, Pakistan
Correspondence: wangx@nefu.edu.com

Keywords: tree rings, growth-climate response, drought variability, ENSO, broad-scale atmospheric-oceanic variabilities

At present, the pace of global warming has led to persistent drought patterns. It is considered to be the preliminary reason affecting socio-economic development under the background of dynamic forecasting of water supply and forest ecosystems in West Asia. However, long-term climate records in the semi-arid Chitral Mountains of northern Pakistan are seriously lacking. Hence, we developed a new tree-ring width chronology of Cedrus deodara spanning the period of 1537–2017. We reconstructed the March–June Palmer drought sensitivity Index (PDSI) for the past 424 years back to A.D 1593. Our reconstruction was featured with nine dry and eight wet periods 1574–1598, 1602–1608, 1631–1645, 1647–1660, 1756–1765, 1785–1800, 1870–1878, 1917–1923, 1981–1995, and 1663–1675, 1687–1708, 1771–1773, 1806–1814, 1844–1852, 1932–1935, 1965–1969 and 1996–2003, respectively. Our reconstruction is consistent with other dendroclimatic reconstructions in Asia. This confirms the reliability of our reconstruction. The analysis of Multi-Taper Method and power spectrum revealed drought variability at periodicities of 2.0–2.4, 3.2, 16.7, 33–37.8, 68, and 78 years. The drought patterns might be linked to the broad-scale atmospheric-oceanic variabilities such as El Niño-Southern Oscillation (ENSO), Atlantic Multi-decadal Oscillation (AMO) and solar activity. As far as current climate conditions are concerned, our findings are of great significance to decision makers in formulating drought-resistant policies for the marginal communities of Hindu Kush Ranges, northern Pakistan.

Acknowledgement

This research was supported by the Key Project of the China National Key Research and Development Program (2016YFA0600800), the Open Grant for Eco-meteorological Innovation Laboratory in northeast China, China Meteorological Administration (stqx2018zd02), the Chinese Scholarship Council (CSC), and the Fundamental Research Funds for the Central Universities (2572017DG02). We appreciate the staff of the International Office, Northeast Forestry University for their excellent services especially. We also thank Dr. Usman, Mr. Shahid Humayun Mirza and Dr. Nasrullah for their helpful comments. We appreciate Mr. Arif Mr. Sher Bahder, Mr. Wali Ullah and Mr. Mushtaq for their great help in the field work.

OR43

Tree ring analysis of himalayan cedar in relation to climate in sub-tropical moist forest of northeast India

Kshetrimayum, Ghanashyam Singh[1]; Nongthombam, Dhirendra Singh[2]; Thingbaijam, Binoy Singh[1]; Thounaojam, Rojen Singh[1]

[1]Manipur University, Ecology Laboratory, Department of Life Sciences, Canchipur 795003, India
[2]Waikhom Mani Girls' College, Wood Science Laboratory, Department of Botany, Thoubal Okram 795138, India
Correspondence: singnd@gmail.com

Keywords: tree-growth, Himalayan cedar, radially-compressed, sub-tropical, northeast

The present study evaluated the tree-ring growth response of himalayan cedar (*Cedrus deodara* Laodon) from sub-tropical moist forest of Meghalaya, India, in relation to climate factors. The growth rings are markedly distinct by the radially-compressed late wood xylem elements. A 115-year chronology was developed after standardization of all the cores. The strength of cross dating among the cores was reflected by an inter series correlation of 0.13; the mean correlation between trees approximately 0.53. The mean sensitivity of the standardized chronology was 0.19. Common interval analysis for the standardized chronology shows a signal to noise ratio of 6.57 with agreement to population chronology 0.86 and a variance due to first eigenvector 27.79%. Response function analysis revealed that a strong positive correlation between ring width and climate. The tree ring growth is more sensitive to temperature rather than influence of precipitation relative humidity. Current year mean temperature of February to September showed positive relation. Whereas, precipitation of current year May to August showed positive response but not significant revealing more sensitivity to temperature factor. Thus the tree serves a potential source of dendroclimatological studies in sub-tropical moist forest of northeast India.

References

Brauning, A., 1999. Dendroclimatological potential of draught-sensitive tree strands in Southern Tibet for reconstruction of monsoonal activity. IAWA 20, 325–338.

Borgaonkar, H.P., Pant, G.B, Rupa Kumar, K., 1996. Ring width variations in Cedrus deodara and its climatic response over the western Himalayas. Journal of Climatology 16, 1409–1422.

Vandana, C., Bhattacharya, A., Yadav, R. R., 1999. Tree ring studies in the Himalayan region : prospects and problems. IAWA 20, 317–324.

Acknowledgement

Present study was conducted through a research grant SERB No. EMR/2016/003782.

OR44

Tree ring formation and intra annual density fluctuation in relation to climate in a sub tropical pine forest

Nongthombam, Dhirendra Singh[1]; Kshetrimayum, Ghanashyam Singh[2]; Thingbaijam, Binoy Singh[2]; Thounaojam, Rojen Singh[2]

[1]Waikhom Mani Girls' College, Wood Science Laboratory, Department of Botany, Thoubal Okram 795138, India

[2]Manipur University, Ecology Laboratory, Department of Life Sciences, Canchipur 795003, India

Correspondence: singnd@gmail.com

Keywords: Pinus wallichiana, ringh width, intra annual density fluctuation, Manipur, north east India

The growth ring patterns in a pine stand of *Pinus wallichiana* in a subtropical forest of Manipur north east India was studied to understand relationship of environmental variables with ring width pattern and intra annual density fluctuation chronologies. The growth ring sequences using tree ring width variations were dated precisely and a ring width chronology (AD 1850–2016) developed. The ring width chronology revealed the integration of mean temperature of April-May-June signal, the radial growth being favoured by cool late spring temperature and early summer. The study of intra annual density fluctuation chronology and climograph of the meteorological station close to study site revealed that dry early growing season lead to the formation of intra-annual density fluctuation pattern in early wood part of the growth rings. However, the intra annual density fluctuation in late wood part of the growth rings are formed due to the wetter condition in the late growing season. The draught conditions in early growing season have socio economic impact as paddy is largely sown in north east India during this period. This finding underscores the potential utility of intra-annual density fluctuation studies in *Pinus wallichiana* to understand extreme climate events in a long term perspective.

References

Campelo, F., Nabias, C., Freitas, H., Gulierreze, E., Cristina, N., 2006. Climate significance of tree ring width and intra-annual density fluctuations in Pinus pinea from dry Mediterranian area in Portugal. Ann. For. Sci 64, 229–238.

Campelo, F., Vieira, J., Battipuglia, G., Luis, M., Nabias, C., Freitas, H., Cherubini, P., 2015. Which matters most for the formation of intra-annual density fluctuation in Pinus pinaster: age or size? Trees 29, 237–245.

Copenheaver, C. A., Pokarsti, E. A., Currie, J. E., Abrams, M. D., 2006. Causation of false ring formation in Pinus banksiana: a comparison of age, canopy, class, climate and growth rate. For. Ecol. Mange 238, 346–355.

Acknowledgement

Present study was conducted through a research grant SERB No. EMR/2016/003782.

OR45

Understanding mortality in two co-occurring Mediterranean coniferous species of different drought-tolerance

Férriz, Macarena[1]; Martin-Benito, Dario[1]; Cañellas, Isabel[1]; Gea-Izquierdo, Guillermo[1]

[1]INIA-CIFOR, Crta. La Coruña km 7.5, 28040 Madrid, Spain
Correspondence: ferriz.macarena@inia.es

Keywords: Pinus pinaster, Pinus pinea, dendroecology, global change, vulnerability to water stress

The Mediterranean Basin is especially sensitive to forecasted increasing drought periods, which will likely induce species distribution shifts, decline and accelerated mortality.

In this work, we explored decline and mortality patterns of two coexisting pine species in central Spain using tree-ring data: declining maritime pine (*Pinus pinaster*) and the more drought-tolerant and not declining stone pine (*Pinus pinea*). We established 75 plots along an altitudinal gradient coincident with the low-altitudinal limit of *P. Pinaster* where we recorded site characteristics and extracted cores from healthy, declining and dead trees of both species. We used dendrochronological data to analyse tree responses to climate and the impact of past disturbances on tree health status. We used logistic regression and ordinal logistic regressions to assess the individual probability of a tree to die and decline in relation to the climatic response, individual tree-growth patterns and site characteristics.

The mortality pattern differed between species. Decline and mortality in maritime pine was more extended in time, suggesting a long-term stressor induces it, whereas the spring precipitation response, resilience after a drought event and microsite quality increased maritime pine survival. In contrast, stone pine survival only responded to two factors, increasing with a higher response to water availability and larger diameters.

The observed differences in species survival suggest that increasing summer droughts will likely reduce maritime pine populations, relegating them to areas with better site conditions. Eventually, this situation will favour more drought-resistant species, like stone pine, which hence will potentially gain dominance in the area.

OR46

Size, not age, affects trees' climate sensitivity

Trouillier, Mario[1]; Van der Maaten-Theunissen, Marieke[2]; Scharnweber, Tobias[1]; Wilmking, Martin[1]

[1]Institute of Botany and Landscape Ecology, University of Greifswald, Germany
[2]Forest Growth and Woody Biomass Production, TU Dresden, Germany
Correspondence: mario.trouillier@uni-greifswald.de

Keywords: size effect, climate sensitivity, dendroecology, Picea glauca, Alaska

Age and size effects on trees' climate sensitivity have been investigated by multiple studies. Most frequently, trees were stratified into age classes after which climate-growth correlations were calculated for these different classes. However, this approach has major drawbacks:
a) Environmental data is typically present as time series. Because tree age increases with time, the mean age within each class increases over time as well. Consequently, age increases might coincide with concurrent temperature or atmospheric CO2-changes, making it difficult to impossible to disentangle these effects.
b) Age-dependent climate sensitivity shifts do systematically overestimate the age where this shift happens. We show that this overestimate is half the length of the climate data time-series.
c) Lastly, the smallest age class is limited by the length of the climate data. For example, 50 years of climate data require that each analyzed tree is at least 50 years old.
Using a well replicated tree ring width dataset of white spruce from Alaska, we show that all these disadvantages can be overcome by using cambial ring-age classes.
Furthermore, by creating stem-diameter classes (cumulative ring width, a proxy for tree height) within cambial ring-age classes, we demonstrate that tree size, rather than age, affects white spruce sensitivity to drought. Likely, wood-anatomical changes related to tree height (see Sanio's law) are responsible for this shift in drought sensitivity. Our results indicate the potential change of maximum tree height under climate change and a potential contribution to the discussion centered around the ‚divergence problem' in northern forests.

References

Konter, O., Büntgen, U., Carrer, M., Timonen, M., Esper, J., 2016. Climate signal age effects in boreal tree-rings: Lessons to be learned for paleoclimatic reconstructions. Quaternary Science Reviews 142, 164–172.

Sanio, K., 1872. Über die Grosse der Holzzellen bei der gemeinen Kiefer (Pinus silvestris). Jb. wiss. Bot. 8, 401–420.

Ryan, M. G., Phillips, N., and Bond, B. J., 2006. The hydraulic limitation hypothesis revisited. Plant, Cell & Environment 29, 367–381.

Acknowledgement

This project was funded by the German Research Foundation (DFG) within the Research Training Group RESPONSE (DFG RTG 2010).

OR47

Predictions of future growth based on tree ring chronologies: How sure can we be?

Huang, Weiwei[1,2]; Fonti, Patrick[3]; Ræbild, Anders[4]; Larsen, Jørgen B.[4]; Wellendorf, Hubert[4]; Hansen, Jon K.[4]

[1]Department of Geosciences and Natural Resource Management, The University of Copenhagen, Rolighedsvej 23, DK-1958 Frederiksberg C, Denmark
[2]Collaborative Innovation Center of Sustainable Forestry in Southern China of Jiangsu Province, Bamboo Research I
[3]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland
[4]Department of Geosciences and Natural Resource Management, The University of Copenhagen, Rolighedsvej 23, DK-1958 Frederiksberg C, Denmark
Correspondence: wh@ign.ku.dk

Keywords: Norway spruce, summer drought, warm autumn, projection

In current study, we present a new approach, based on a mixed model procedure, to project the growth trends of Norway spruce (*Picea abies* (L.) Karst.) under different climate change scenarios with a stand-scale process-based model.
We performed climate-growth analyses for 340 trees (dataset 1) over 14 Norway spruce stands during 1950–1987 from a Danish breeding program which was used to improve productivity and wood quality. Our goal of analysis is to identify the major growth constraints and assess the corresponding impacts under future climatic scenarios (Rcp4.5 and 8.5). In addition, tree ring data of 36 Norway spruce trees of six trials over the period 1972–2012 (dataset 2) from Danish common garden experiment was added to this study to further explore how different sites, tree-ring periods could influence the projection. To identify and quantify the main climatic constraints we applied growth-climate correlations and multiple linear regression models. Tree growth was then projected up to 2100 applying the multiple linear regression models based on the fifteen Global Climate Models (AOGCMs) of the Coupled Model Intercomparison Project Phase 5 (CMIP5).
Our results showed that over the past 60 years summer drought but also high late-summer and early-autumn temperatures substantially negatively affected the growth of Norway spruce across Denmark. Our models suggest that Norway spruce will experience important growth reduction by 31.5% using dataset 1, while 19.8% based on dataset 2 under Rcp8.5 by 2080s (i.e., 2071–2100). This reduction will occur due to a tightening of drier summer and warmer autumn in the recent future century.
Different climate change scenarios, climate models, sites variation and time-spans lead to uncertain projections of the future productivity of Norway spruce forests. Hence, there is a need for a continuous effort to improve predictions from applicable sites, downscaled geographic range, more climate models under different scenarios, and better bioclimatic models selection, etc. These uncertainties also need to be integrated into forest management planning and adaptation of forest management to climate change using adaptive management frameworks.

OR48

Divergent tree physiological states in black spruce stands and their implications for millennial-long dendroclimatic reconstructions

Gennaretti, Fabio[1]; Arseneault, Dominique[2]

[1]INRA Centre Grand Est – Nancy, UMR1434 Silva, Rue d'Amance, 54280 Champenoux, France
[2]Université du Québec à Rimouski, Centre d'études Nordiques, Département de biologie, chimie et géographie, 300 Allée des Ursulines, Rimouski, QC G5L 3A1, Canada
Correspondence: fabio.gennaretti@inra.fr

Keywords: living and subfossil trees, tree-growth trajectories, tree decline and mortality, leaf area, temperature reconstruction

We are building one of the highest replicated tree-ring dataset over the last two millennia using subfossil and living black spruce trees of the northern boreal forest of Canada. The resultant chronologies correlate with summer temperature and a part of them was already used for temperature reconstructions. In order to provide robust chronologies especially over the last 100 years, we analyze here the growth patterns of the living trees at the sampling sites. We show that alternative physiological states are common in the same black spruce stand. Healthy trees with well-formed complete crown may stand not far from trees with eroded crown structure in the sampled open woodlands. These two groups have divergent tree-growth trajectories, with the eroded trees showing a declining long-term trend leading likely to tree mortality. The divergence of a large portion of the eroded trees started in the 1920s–1930s when the region experienced severe droughts and fire years. We also quantify with an ecophysiological model the progressive total leaf area reduction per tree needed to explain the growth trend of the eroded group. Finally, when we merge only eroded living trees and subfossil logs in the same chronology, the resultant temperature reconstruction unrealistically amplifies the warming over the medieval period relative to the Little Ice Age and the 20th century. This study stresses the importance of the selection of living trees, of a comprehensive analysis of tree ecophysiology and of the choice of the standardization method for dendroclimatological applications.

OR49

Aleppo pine forest decline in semiarid Mediterranean ecosystems in southeast Spain

Novak, Klemen[1]; Muñoz-Rengifo, Julio[2]; De Luis, Martin[3]; Morcillo, Luna[4]; Vilagrosa, Alberto[4]

[1]University of Ljubljana, Biotechnical Faculty, Department of Wood Science and Technology, Rozna dolina, Cesta VIII/34, 1000 Ljubljana, Slovenia
[2]Universidad Estatal Amazónica, Departamento Ciencias de la Tierra, Bloque D, Km. 2. 1/2 vía Puyo a Tena (Paso Lateral), Pastaza, Ecuador
[3]University of Zaragoza, Department of Geography, Pabellón de Geografía, San Juan Bosco 7, 50009, Zaragoza, Spain
[4]Fundación CEAM, Joint Research Unit University of Alicante-CEAM, Univ. Alicante, PO Box 99, 03080 Alicante, Spain
Correspondence: klemen.novak@bf.uni-lj.si

Keywords: Pinus halepensis, growth-climate relationship, tree mortality, extreme drought events, bark beetles outbreaks

Under the ongoing climate change with more frequent and prolonged drought and heat waves, the future of the forests ecosystems in the Mediterranean is unpredictable. *Pinus halepensis*, a native tree species forms large forests in extensive areas. Its morpho-functional characteristics show high plasticity to tolerate the variability and the severity of Mediterranean climatic conditions.
After an extreme drought event occurred few years ago, an extensive tree mortality was observed in different forests in SE Spain, with visible signs of bark beetles attacks. The occurrence of frequent and prolonged droughts must have an important role on tree-growth decline. Previous studies reported on delayed effects, stating not to be caused by a single drought event but likely an accumulative effect of previous ones. Their recurrence may weaken the trees making them more vulnerable for bark beetles attacks, which may trigger their mortality.
In this study we analysed the impact of droughts on *Pinus halepensis* forests and their recovery capacity. We tested whether the triggering factor for tree-growth decline was an extreme drought occurred 2014 or a delayed effect of previous ones which together with pest outbreaks could be the cause for tree mortality.
We analysed ecophysiological and dendrochronological variables of tree vigour and growth during the last decades to determine the causes of forest decline. The main results pointed out that pine mortality was the consequence of the extreme dry conditions, since no differences in dendrochronolgical analysis were found among living and dead pines in the years before the mortality episode.

References

Camarero, J.J., Gazo, I. A., Sangüesa-Barreda, G., Cantero, A., Sánchez-Salguero, R., Sánchez-Miranda, A., Granda, E., Serra-Maluquer, X., Ibáñez, R., 2018. Forest Growth Responses to Drought at Short- and Long-Term Scales in Spain: Squeezing the Stress Memory from Tree Rings. Front. Ecol. Evol. 6, Article 9.

García de la Serrana, R., Vilagrosa, A., Alloza, J.A., 2015. Pine mortality in southeast Spain after an extreme dry and warm year: interactions among drought stress, carbohydrates and bark beetle attack. Trees 29, 1791–1804.

OR50

Variability in masting of European beech at different time scales: analysis of 329 year long dendrochronological reconstruction from Southern Sweden

Drobyshev, Igor[1]; Mats, Niklasson[2]

[1]Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre, Alnarp Sweden & University of Quebec at Abitibi-Temiscamingue, Canada
[2]Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre, Alnarp Sweden
Correspondence: igor.drobyshev@slu.se

Keywords: dendrochronological reconstruction, tree masting, climate forcing, reproductive behavior

Masting in European beech (*Fagus sylvatica*), i.e. production of abundant crops in some years, is an important ecological factor driving species regeneration and impacting different trophic levels of forest ecosystem. Understanding the environmental controls of masting helps predict ecosystem responses to environmental forcing. We developed a 329 year long record of F. sylvatica masting in Southern Sweden, using a combination of observational records and tree-ring based reconstruction. The mast record exhibited pronounced decadal variability, with increased mast frequencies during 1700–1750, 1840–1850, and since 1970s. At the high-frequency range, mast years were triggered by a combination of low and high pressure systems dominating regional summer conditions two and one years prior mast year, respectively. Variability in mast frequencies at decadal and centurial frequencies was related to the variability in atmospheric pressure patterns, periods with lower pressure demonstrating increased mast frequencies. Comparison of long European mast chronologies of F. sylvatica suggests synchronicity in low frequency variability in masting over the subcontinent. We discuss physiological controls and evolutionary factors which shape temporal patters of beech masting in Europe.

OR51

Beech seedlings are more prone to hydraulic dysfunction in spring than in summer

Plichta, Roman[1]; Hájíčková, Martina[1]; Urban, Josef[1]; Volařík, Daniel[1]; Gebauer, Roman[1]

[1]Mendel University in Brno, Faculty of Forestry and Wood Technology, Dep. of Botany, Dendrology and Gobiocoenology, Zemědělská 3, 613 00 Brno, Czech Republic
Correspondence: roman.plichta@mendelu.cz

Keywords: cavitation, xylem refilling, functional anatomy

Both summer and spring droughts are increasing in its frequency and severity, playing a decisive role in tree vitality and survival. However, tree adaptation to drought and subsequent recovery may vary over the growing season. The complex relationships between leaf gas exchange, vascular anatomy, morphology, and biomass allocation were studied in a controlled experiment on one-year-old European beech (*Fagus sylvatica* L.) seedlings, which were exposed to drought stress and then re-watered. The drought was imposed at an early stage of leaf development (spring) and with fully developed leaves (summer). Very low mortality of seedlings in both spring and summer, and all levels of drought (predawn leaf water potential up to –3.9 MPa) suggested high resistance and resilience of beech seedlings to drought. Spring seedlings reduced cell division and expansion, especially in stem and shoots, which was in contrast to summer seedlings, where neither anatomy nor morphology was affected. Although all seedlings stringently reduced leaf gas exchange during drought, they significantly lost stem hydraulic conductance and xylem functional area, especially in spring (more than 90%). Decreasing xylem hydraulic conductivity was accompanied by the reduction in functional leaf area, which was the way how to moderate the negative effect of hydraulic loss. Although the recovery of functional xylem was observed mostly within the current-year tree ring, the restoration of stem hydraulic conductance was the slowest process of all. The anatomical and morphological alterations of spring seedlings with extensive hydraulic deterioration suggest their higher adaptability but lower resistance to drought.

Acknowledgement

Supported by post-doc project within institutional plan of MENDELU 2019–2020.

OR52

Woody species-specific disturbance regimes and strategies in mixed mountain temperate forests in the Šumava Mts., Czech Republic

Kašpar, Jakub[1]; Šamonil, Pavel[1]; Vašíčková Ivana[1]; Adam, Dušan[1]; Daněk, Pavel[1]

[1]The Silva Tarouca Research Institute, Department of Forest Ecology, Lidická 25–27, Brno 602 00, Czech Republic
Correspondence: jakub.kaspar@vukoz.cz

Keywords: Picea abies, Fagus sylvatica, growth plasticity, disturbance history, forestry management

The disturbance regime of mountain spruce-beech temperate forests has not yet been sufficiently uncovered. We hypothesize that spruce and beech express completely different disturbance histories and behavioural strategies, potentially causing exceptionally complex disturbance regimes. We further hypothesize that the spontaneous development of mountain forests can temporarily result in the simplification of the forest's spatial structure. We want to discover how the disturbance history and growth plasticity of the main tree species differs, and whether some old managed forests arose from primeval forest remnants. We compared dendrochronological records of the unmanaged Boubín Primeval Forest and 30 sites with current forestry records. Using this comparison we categorized all sites into three categories. In the disturbance history of all evaluated forest sites there was clear evidence of the presence of severe disturbances in the 19th century. However, the regeneration of beech was more continuous and less dependent on the presence of severe disturbances than the regeneration of spruce, which depended on the presence of severe disturbances of low frequency. Human induced changes at some sites were manifested in changes in the initial growth of both species and disrupted their mutual competition, and also led to a higher growth plasticity of beech. Despite human impacts in the region since the end of the 19th century, about 30 % of analysed trees were older than the severe disturbances in the 19th century, and some studies sites preserved the characteristics of primeval forest. Our results revealed three main forest development trajectories since the end of the 19th century.

Acknowledgement

This study was supported by the Czech Science Foundation (project No. 19-09427S) and partially by the Forests of the Czech Republic, state enterprise and the Šumava National Park, state contributory organization, contract No. 6/2016. We would like to thank Anna Rousová, and Daniel Cigánek for their help in the field and during sample preparation.

OR53

Dendrochronological quantification of natural disturbances in the European mountain spruce forests as a guideline for management

Čada, Vojtěch[1]; Trotsiuk, Volodymyr[1,2,3]; Janda, Pavel[1]; Mikoláš, Martin[1,4]; Bače, Radek[1]; Nagel, Thomas A.[5]; Morrissey, Robert C.[1]; Tepley, Alan J.[6]

[1]Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Department of Forest Ecology, Kamycka 129, 165 00 Praha 6 – Suchdol, Czech Republic
[2]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland
[3]Institute of Agricultural Sciences, ETH Zurich, Universitätsstrasse 2, CH-8092 Zurich, Switzerland
[4]PRALES,o.z., Odtrnovie 563, 013 22 Rosina, Slovakia
[5]University of Ljubljana, Kongresni trg 12, 1000 Ljubljana, Slovenia
[6]Smithsonian Conservation Biology Institute, Washington, D.C. 20013-7012, USA
Correspondence: cada@fld.czu.cz

Keywords: disturbance-based forestry, disturbance regime, intermediate disturbances, old-growth, Picea abies

As unsuitable forest management is causing significant threats in many areas of the world, many foresters believe that using natural disturbance patterns of primary forests as a guideline for management will guarantee the long-term sustainability of forest ecosystem structure, composition and functions. Our objective was to quantify the past disturbances' severity, patch size, and stand proportion disturbed of the remaining Central and Eastern European primary mountain spruce forests. Tree-ring disturbance proxies, rapid early growth rates and releases from suppression, which were aggregated at the plot and stand levels by smoothing and detecting peaks in their distributions, were used to quantify individual disturbance events and their characteristics. The spatial aggregation of disturbance events was used to estimate patch sizes. Disturbances were characterized by a continuous gradient of low to high severity and small to large events. In addition to small events, we demonstrated the significance of moderate-scale (25–75% of the stand disturbed, >10 ha patch size) and moderate-severity (25–75% of canopy disturbed) disturbance events. They affected about 50% of the area and their rotation periods were within the spruce lifespan of one to several hundred years. The observed disturbance patterns (mixed severity disturbance regime with significant effect of moderate scale events) likely affect a large portion of global forests and, therefore, deserve attention. Natural disturbance patterns should be used as a guide for management because they create conditions consistent with native species requirements.

OR54

Methodological challenges and pitfalls in cross-dating of tree roots subjected to trampling (Pinus sylvestris L., NE Poland)

Matulewski, Paweł[1]; Buchwal, Agata[1]; Gärtner, Holger[2]; Zielonka, Anna[3]; Wrońska-Wałach, Dominika[3]; Čufar, Katarina[4]

[1]Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Poznań, Poland
[2]Swiss Federal Research Institute WSL, Birmensdorf, Switzerland
[3]Institute of Geography and Spatial Management, Jagiellonian University, Kraków, Poland
[4]Department of Wood Science and Technology, University of Ljubljana, Slovenia
Correspondence: matul@amu.edu.pl

Keywords: tree roots, cross-dating, radial growth changes, root exposure, Pinus sylvestris L.

Cambial activity in roots and stems is frequently divergent and depends on various factor. As a result problems related to the correlation of tree-ring growth in roots and the stem of the same tree were recognized.

The main goal of this study is to characterize radial growth changes in Scots pine (*Pinus sylvestris* L.) roots subjected to trampling in Brodnica Lakeland (NE Poland). We present a compiled method for a quantitative analysis of ring-growth irregularities of tree roots performed in three root zones of the root system: i) exposed parts of roots; ii) buried root zone close to the stem; and iii) transition zone of exposed and buried roots. In total 187 root disks from 42 trees were analyzed.

In order to identify radial growth changes, as well as to perform a precise dating of the roots, a stepwise cross-dating procedure was conducted, including a comparison of growth curves from different roots zones with the stem growth and a reference site chronology.

The study revealed high discrepancies in radial growth pattern between various zones of the root system, as well as between the roots and the respective stem. The highest correlation (period 1965–2015) between stem and root growth was found for the exposed roots ($r = 0.84$ for residual root chronology). The highest mean number of wedging rings was detected in the exposed roots (72%), whereas the highest mean number of missing rings was observed in the buried roots (16%). It was revealed that without serial sectioning the age of single root disks could be underestimated for up to 27%. Correlation between exposed roots and stem radial growth was positively influenced by soil compaction, age of root discs and height of the exposed part of the root, but negatively by the distance from the stem.

OR55

Are forests getting younger? A case study of environmental changes impact on growth dynamics of primary forests of Carpathians.

Begović, Krešimir[1]; Janda, Pavel[1]; Schurman, Jon[1]; Rydval, Miloš[1]; Pavlin, Jakob[1]; Langbehn, Thomas[1]; Svoboda, Miroslav[1]

[1]Czech University of Life Sciences Prague (CULS), Faculty of Forestry and Wood Sciences, Dep. of Ecology, Kamycka 129, 16500 Prague, CZ
Correspondence: begovic@fld.czu.cz

Keywords: primary forests, tree-rings, basal area growth, Carpathians, Norway spruce

Carpathian primary forests are one of Europe's most substantial carbon reserves and a refuge for numerous European endemic species. These forests play an important role in mitigating the effects of climate change, acting as the carbon sink and by preserving the natural structural features, which in the end support biodiversity and preserve species richness.
From the beginning of 21st century, several studies have shown that tree growth had accelerated during the last couple of decades, while contrasting growth responses suggest that young trees are particularly responsive to warming climate, while reduced growth in old trees could alter the species' potential as a carbon sink in the future.
Based on tree-ring analysis, growth rates of Norway spruce trees from Slovakian Carpathians were classified into 30-year age classes. Growth rates were calculated as basial area increment (i.e. BAI) for all trees and averaged per site. In order to fully realize the trade-off relationship between age and growth, repeated-measure of variance (ANOVA) was used. Furthermore, growth rates of individual trees in the last 30 years (since the theoretically accepted beginning of climate change) will be compared to past growth trends, disturbance histories on different spatial scales and environmental factors. Linear mixed-effect model will be applied to correlate and differentiate impact of driving growth-factors and age of spruce stands.
Preliminary results showed most trees exhibited an increasing BAI throughout their lives, regardless of age. Our results should be able to contribute to the hypothesis of stimulatory effects of global change phenomenon on forest development.

OR56

Response of alike tree species at different sites of IHR along treeline ecotone

Phulara, Mohit[1]; Joshi, Rajesh[1]; Bhattacharya, Amalava[2]; Upadhyay, Rajeev[3]

[1]GB Pant National Institute of Himalayan Environment & Development Kosi-Katarmal, Almora, Uttarakhand 263643, India
[2]Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow, 226007, India
[3]Department of Geology (CAS), Kumaun University, Nainital, 263001, India
Correspondence: phularamohit14@gmail.com

Keywords: treeline, timberline, tree rings, climate change, Himalaya

The treeline ecotone refers to the transition from the timberline to grasslands (alpine vegetation). Number of studies have targeted on influence of climatic modification on treeline dynamics. Treeline shift rate is additionally thought about to be a imprint of influence of worldwide changes on terrestrial ecosystems. However, it is lesser known about how other factors mediates the response of treelines to climate change. Altitudinal treelines are very heterogeneous and show a great physiognomic, genetic, and ecological variety due to their geographical position and landscape. But if to consider the same species at two different sites of varying climatic as well as geographical conditions, what would be its response. The present study aims to address the influence of variation of these factors on same treeline species at two different climatic regime sites, one from western Himalaya and the other from north-western Himalaya. Thus far, few results have been generated from one site of western Himalaya are as follows: a) Amongst several factors, winter warming could have played an important role in the high growth b) The treeline shift rate estimated as 1.37 m/yr. Still much to find and to present in future studies. As, tree ring variations are the result of several affecting factors in a specified site. Therefore, the mechanism of tree growth response is complex at treeline ecotone and needs to be better understood.

Acknowledgement

Thanks to Dr. Rajesh Joshi for all his supports and for funds to NMHS-PMU & CHEA. Many thanks to GBPNIHESD and my labmates and friends.

OR57

Resilience in some lower Himalayan conifers under disturbed condition; a preliminary tree ring study of growth

Khan, Afsheen[1]; Ahmed, Moinuddin[1]; Khan, Adam[1]

1Dr. Moinuddin Ahmed Research Laboratory of Dendrochronology and Plant Ecology, Department of Botany Federal Urdu University Gulshan Iqbal Campus Karachi, Pakistan
Correspondence: khanafsheen913@ymail.com

Keywords: Growth rate, correlation,, Himalayan forest, forest health, dendrochronology

Murree and its galyat are the targeted sites where the peak of disturbance can be easily seen, four pine species were recorded from there i.e. *Pinus wallichiana* A.B.Jackson, *Pinus roxburghii* Sarg, *Cedrus deodara* (Roxb.) G. Dong and *Abies pindrow* (Royle ex D.Don) Royle. Highest Dbh range was observed in *Abies pindrow* i.e. 12.8 to 36.48cm while oldest trees in the study area mostly belonged to *Pinus roxburghii* (217 years) and *Pinus wallichiana* (208 years) widest range of growth rate was estimated from *Pinus wallichiana* i.e. 0.94yr/cm to 8.67yr/cm. Correlation between age and growth rate and Dbh and growth rate of all four conifers was highly significant (p> 0.001). Correlation was highly significant (p> 0.001) in *Pinus roxburghii*, *Pinus wallichiana* and *Cedrus deodara* and non-significant in *Abies pindrow*.

References

Abrams, M. D., Nowacki, G.J., 2008. Native Americans as active and passive promoters of mast and fruit trees in the eastern United States. The Holocene 18, 1123–1137.

Ahmed, M., Ogden, J., 1987. Population Dynamics of the emergent conifer Agathis australis (D.Don) Lindl. (Kauri) in New Zealand. New Zealand J. Bot. 25, 231–242.

Bigler, C. Veblen, T.T., 2009. Increased early growth rates decrease longevities of conifers in subalpine forests. Oikos 118, 1130–1138.

Acknowledgement

Department of Forestry, Punjab and KPK, Pakistan.

OR58

Exploring the dendroecological potential of riparian Poplar trees, Caledon river, South Africa

Kemp, Marthie Elizabeth[1]

[1]*Univeristy of the Free State, Centre for Environmental Management, Bloemfontein, South Africa*
Correspondence: kempm@ufs.ac.za

Keywords: Dendroecology, South Africa, Populus sp, Caledon River, riparia

Although dendrochronology is a mostly underexplored discipline in Southern Africa, dendrochronological work in Africa is on the increase (Gebrekirstos et al, 2014). The southern tip of Africa have limited indigenous forests, covering only 0.25% of the area. Furthermore, this region's indigenous hardwood trees are primarily adapted for arid to semi-arid conditions, making their crossdating more complex. European colonization, commencing in 1652, brought a large number of alien and invasive tree species from the Northern Hemisphere to this region for commercial and ornamental purposes. Amongst them were a number of Poplar species introduced during the 1880s, which invaded the riparian zone of numerous rivers. Not much is known about the ecological responsiveness of this alien invasive tree to changing environmental conditions in the riparia of this region. This study is a first attempt in South Africa to use tree ring data to determine the stand-age structure of Poplar in the riparia of the Caledon River. Poplar trees of different diameter sizes, occurring at different distances from the river, were measured, cored and is being analyzed using standard dendrochronological techniques. Exact age dating is key to determine both the time of establishment of a specific tree population, and to determine how these trees respond to changing riparian conditions over time. If Poplar trees occurring along the Caledon River are ecologically responsive enough to crossdate, this study can contribute to future environmental reconstructions in similar riparia.

References

Gebrekirstos, A., Bräuning, A., Sass-Klassen, U., Mbow, C., 2014. Opportunities and applications of dendrochronology in Africa. Current Opinion in Environmental Sustainability 6, 48–53.

Poster presentation

PO01

A preliminary result from ecological wood anatomy of Quercus ilex in different regions of Turkey

Akkemik, Ünal[1]; Yılmaz, Hatice[2]; Sevgi, Orhan[3]; Sevgi, Ece[4]; Yılmaz, O. Yalçın[5]

[1]Istanbul University-Cerrahpasa, Faculty of Forestry, Department of Forest Botany, Bahçeköy – Sarıyer, İstanbul, Turkey
[2]Istanbul University-Cerrahpasa, Vocational School of Forestry, Department of Ornemental Plants, Bahçeköy – Sarıyer, İstanbul, Turkey
[3]Istanbul University-Cerrahpasa, Faculty of Forestry, Department of Soil Science and Ecology, Bahçeköy – Sarıyer, İstanbul, Turkey
[4]Bezmialem Vakıf University, Faculty of Pharmacy, Pharmaceutical Botany Department, Fatih, İstanbul, Tukey
[5]Istanbul University-Cerrahpasa, Faculty of Forestry, Department of Surveying and Cadastre, Bahçeköy – Sarıyer, İstanbul, Turkey
Correspondence: uakkemik@istanbul.edu.tr

Keywords: Quercus ilex, wood anatomy, tree ring, holm oak, sensitivity

Quercus ilex L. (Holm oak) has small stands from sea level up to 300 m in the Black Sea region and up to 1100 m in the Aegean region of Turkey. The aim of this study is to compare the anatomical characteristics of the woods taken from different growing sites of the species. Total 60 wood pieces were collected from 60 sites of its distribution areas. They were 7 samples from central Black Sea Region (0–100 m), 20 samples from western Black Sea region (0–300 m), 25 samples from west-central Aegean (0–400 m), and 8 from southwestern Aegean (900–1100 m). Vessel lengths, radial and tangential diameters and vessel numbers per square mm were measured on total 60 samples. Cluster analysis was made according to the vessel sizes and their numbers per square mm. Furthermore, mesomorphy and xeromorphy ratios were determined.

Because of wood feature, xeromorphy (0.14–1.00) and mesomorphy ratios (931–10372) produced extreme values and did not work well. The results of the cluster analysis revealed three main groups. These groups were related with dry and wet sites and slightly with elevation. No exact regional group with vessel features was observed. Some woods from the Aegean and Black Sea regions fell into the same groups because of being similar local dry and wet conditions in both regions.

In the final step of the study, 40 more samples will be collected and wood anatomical features on total 100 samples from whole distribution areas of the species in Turkey will be analyzed. Vessel diameters of each tree-ring in the last 15–20 years of the appropriate samples, ring widths and their sensitivities will be analysed.

PO02

Regeneration potential of confers in lesser Himalayan tropics under disturbance

Baz, Sher[1]; Khan, Afsheen[1]; Ahmed, Moinuddin[1]; Shaukat, Syed Shahid[2]

[1]Dr. Moinuddin Ahmed Research Laboratory of Dendrochronology and Plant Ecology Department of Botany. Federal Urdu University of Arts, Science and Technology Karachi, Pakistan.
[2]Department of environmental Studies, University of Karachi, Pakistan.
Correspondence: khanafsheen913@ymail.com

Keywords: regeneration, seedling dynamics, growth rate, future trend, forest health

The current study focuses on the regeneration potential of four conifer species namely, *Pinus wallichiana*, *Pinus roxburghii*, *Cedrus deodara* and *Abies pindrow*. The parameters chosen for the assessment of regeneration potential were age and growth rate. In addition, edaphic and topographic characteristics of the thirty disturbed stands were determined. The 'disturbed' stands were deterministically selected because these were found to be deteriorating and it is important to evaluate the regeneration potential of such forests. Seedling density varied in the order: *Pinus wallichiana* > *Pinus roxburghii* > *Cedrus deodara* > *Abies pindrow* while the growth rate was exhibited in the order *Pinus roxburghii* > *Pinus wallichiana* > *Abies pindrow* > *Cedrus deodara*. These findings suggest the *Pinus roxburghii* is the most suitable species to regenerate and conserve these forests.

References

Ahmed, M., Ogden, J., 1987. Population Dynamics of the emergent conifer *Agathis australis* (D.Don) Lindl. (Kauri) in New Zealand. New Zealand J. Bot. 25, 231–242.

Ahmed, M., 2014. The Science of Tree Rings: Dendrochronology. Qureshi Arts Press. Karachi Pakistan. 302 pp.

Siddiqui, M. F., 2011. Community structure and dynamics of conifer forests of moist temperate areas of Himalayan range of Pakistan. Doctoral dissertation, Department of Botany, Federal Urdu University of Arts Sciences and Technology Karachi

Acknowledgement

Department of Forestry Punjab and KPK, Pakistan.

PO03

Tree-ring based dating of the wooden temple in Górzanka (SE Poland)

Bijak, Szymon[1]; Dzięcioł, Grażyna[2]

[1]Warsaw University of Life Sciences – SGGW, Faculty of Forestry, Nowoursynowska 159, 02-776 Warszawa, Poland
[2]Warsaw University of Life Sciences – SGGW, Faculty of Wood Technology, Nowoursynowska 159, 02-776 Warszawa, Poland
Correspondence: szymon.bijak@wl.sggw.pl

Keywords: wooden buildings, age determination, orthodox church

The objective of the study was to determine the date of the construction of the Roman-Catholic (formerly the Greek-Orthodox) church in Górzanka (south-eastern Poland), which has had a status of the cultural monument since 1975. According to some sources the temple construction is dated to either 1718 or 1838. We used 25 samples taken from various structural elements of the building and applied the dendrochronological method to determine the date of the church construction. The local floating chronology created on the basis of investigated samples was cross-dated based on the chronologies from the area of Ostrava (Czech Republic) and of Komarnik (Slovakia). We found higher similarity with the Czech chronology. The majority of the samples come from the same period, i.e. the second half of the 1830s, which allows to determine the construction date to around 1840. There were also some samples from the second half of the 18th century, which may indicate the secondary use of wood in the construction of the present church.

PO04

dd+ A new dendro Software for large data sets and for institutions with archives

Bleicher, Niels[1]**; Walder, Felix**[1]

[1]*Underwater- and Dendroarchaeology Zurich*
Correspondence: niels.bleicher@zuerich.ch

Keywords: software, archive, crossdating, data consistency

We present dd+, a new dendro software for managing, browsing, mapping and crossdating large data sets as well as for managing metadata and archives. In this SQL server database, context information are kept along with measurements and archive information. Mean curves are stored along with their internal structure. Data consistency is checked and ensured by algorithms. An Interface for GIS exists as well. It has powerful crossdating routines able to process thousands of series at a time.
dd+ is run as a community-driven software. The users share the costs of maintenance, support and further development.

PO05

A step-by-step guide to describe wood formation

Campelo, Filipe[1]; Vieira, Joana[1]

[1]Centre for Functional Ecology – Science for the People & the Planet, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal
Correspondence: fcampelo@uc.pt

Keywords: Pinus pinaster, cambial activity, wood formation, Gompertz, GAMs

Wood formation is one of the most important biological processes for trees. Recently it has received increased attention from researchers because it can help to predict the response of forests to climate changes. The Gompertz growth model is usually used to describe wood formation in conifers of temperate and cold environments. In these environments, the Gompertz curve can accurately estimate the total number of cells produced during the growing season and describe the intra-annual growth pattern, since tree growth takes place during a short period. However, if the growing season is longer or presents more than one period of growth, the Gompertz curve is not appropriate. Here we introduce a new method to describe cambial activity and wood formation in species with a long growing season and two main peaks of growth, one in spring and one in autumn. To illustrate this method we used *Pinus pinaster*, a conifer with a bimodal growth pattern. We compared the cambial activity and wood formation of *P. pinaster* estimated using the Gompertz and our method, which combines different constrained GAMs, in order to define the strengths and limitations of both methods. Our results show that both methods successfully estimated the number of tracheids produced during the growing season, but the intra-annual wood formation pattern in P. pinaster was detected only by our approach.

Acknowledgement

This study was supported by the Fundação para a Ciência e a Tecnologia, Ministério da Educação e Ciência (FCT) co-financed by Compete, through the project STEM2 (PTDC/AAG-GLO/4784/2014).

PO06

Growth reaction of different Scots pine provenances planted in the central Poland

Chojnacka-Ożga, Longina[1]; Ożga, Wojciech[1]

[1]Warsaw University of Life Sciences – SGGW, Faculty of Forestry, Dep. of Forest Silviculture, Nowoursynowska 166 ST. 02-787 Warsaw, Poland
Correspondence: longina_chojnacka_ozga@sggw.pl

Keywords: Pinus sylvestris, tree-rings, climate-growth relationships, provenances, Poland

The aim of this study was to determine the growth variability of nine provenances of *Pinus sylvestris* experimental plots in the Central Poland (Rogów Forest Experimental Station). We selected 15 trees from each provenance, samples were taken as discs at breast height (1,3 m). The analyses were conducted using classical dendrochronological techniques. Tree-ring chronologies, basic statistics and relations climate-growth relations were developed for each provenance. The similarity between the provenances was determined (the Hierarchical Cluster Analysis, convergence GLK and correlation coefficients, t-value). The analysis was carried out for years 1970–2015.

Clustering reveals that the growth patterns were similar for all provenances, differences were small and insignificant. The highly values of the synchronicity and correlation coefficients and the normalized Euclidean distances between the provenances showed that the interannual variability of tree-ring width for all the provenances reflects the prevailing influence of the local weather conditions.

Factors influencing formation of tree-ring widths hardly differ between the provenances. The main factor limiting tree-ring width was law temperature of early spring (March–April). Temperature in April determined the starting day of cambium initiation for all provenances. High summer temperatures in current year had a negative impact on tree-ring width. The role of precipitations was much smaller, however summer drought (July–August) was a clear climatic signal. The impact of extreme summer droughts on Scots Pine of all provenances was observed in 1992, 2003 and 2013.

References

Savva, Yu.V., Schweingruber, F.H., Kuzmina, N.A., Vaganov, E.A., 2002. Sensitivity of diameter growth to annual weather conditions in Scots pine provenances at a Central Siberian location. Silvae Genetica 51, 49–52.

Barzdajn, W., Kowalkowski, W., Chmura, D. J., 2016. Variation in growth and survival among European provenances of Pinus sylvestris in a 30-year-old experiment. Dendrobiology 75: 67–77.

PO07

The role of the climatic factors in the process of ash dieback in Poland.

Chojnacka-Ożga, Longina[1]; Ożga, Wojciech[1]

[1]Warsaw University of Life Sciences – SGGW, Faculty of Forestry, Dep. of Forest Silviculture, Nowoursynowska 166 ST., 02-787 Warsaw, Poland
Correspondence: longina_chojnacka_ozga@sggw.pl

Keywords: climate change, Fraxinus excelsior, ash dieback, tree rings, stem analysis

Most of studies concerning growth of ash done so far were based only on tree-ring widths sequences at breast height. In this study we investigated the growth reaction along the trunk of ash trees growing in the old natural stand affected by ash decline in the southern Poland. We asked the following questions: (i) whether and how the process of ash dieback is noted down in tree-ring widths at different heights of the trunk; (ii) could the potential impact of climatic conditions be estimated on process of ash dieback.

We selected and cut down12 trees differing by health status. Samples were taken as discs from the13 heights, from the base of the trunk up to the top. Annual tree-ring, earlywood and latewood widths were measured, and chronologies were established. The tree-ring data were correlated with monthly values of temperature, precipitation, vapour pressure deficit and selected drought indices. We found an only slight variability of radial growth reactions at different heights along the trunk. Only within the crown, the growth pattern was different than the rest of the trunk. No significant differences were found between analysed ash trees groups.

Climate–growth relationships were changed over time. We found that visible shifts between monthly relations and shifts in strength of relations for last decades occurred. The role of winter weather conditions decreased, while the role of humidity conditions in April and June increased. We show our concept of the relationship between the changing weather conditions in April and June in last years and the process of dying ash. Finally, we show our concept of the role of climatic factors in ash dieback.

References

Goberville, E., Hautekèete, N-C., Kirby, R.R., Piquot, Y., Luczak, C., Beaugrand, G., 2016. Climate change and the ash dieback crisis. Scientific Reporst 6, Article number 35303.

Pušpure, I., Gerra-Inohosa, L., Matisons, R., Laiviņš, M., 2017. Tree-ring width of European ash differing by crown condition and its relationship with climatic factors in Latvia. Baltic Forestry 23, 244–252.

Tulik, M., Zakrzewski, J., Adamczyk, J., Tereba, A., Yaman, B., Nowakowska, J.A., 2017. Anatomical and genetic aspects of ash dieback: a look at the wood structure. iForest 10: 522–528.

PO08

Effect of competition on spruce wood density

Čada, Vojtěch[1]**; Kníř, Tomas**[1]

[1]*Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Department of Forest Ecology, Kamycka 129, 165 00 Praha 6 – Suchdol, Czech Republic*
Correspondence: cada@fld.czu.cz

Keywords: dendroclimatology, tree-ring research, competition, wood density

Competition is a prominent factor that influence tree ring-widths and complicates the effectivity of ring-width data in dendroclimatological studies. In this study we test the hypothesis that wood density, as another useful dendroclimatological proxy, is not influenced by competition to such extent as ring-width. The study was performed in old natural monospecific mountain spruce forests of the Czech Republic at 5 study plots in 4 mountain ranges, where wood density of increment cores from 98 trees growing on permanent study plots were measured and Hegyi's competition index was calculated for each tree. We found no significant effect of competition on the wood density, which support it's potential for dendroclimatological studies.

PO09

Ecoclimatological differentiation and climate susceptibility of European beech (Fagus sylvatica L.) from Balkan Range Mountain (Bulgaria) dendrochronological network

Dimitrov, Dimitar Petrov[1]; Zafirov, Nikolay[2]; Zhiyanski, Miglena[3]

[1]Forest Research Institute – Sofia, Bulgarian Academy of Sciences
[2]University of Forestry – Sofia
[3]Forest Research Institute – Sofia, Bulgarian Academy of Sciences
Correspondence: dimitrov_117@abv.bg

Keywords: dendrochronological network, European beech, ecoclimatological differentiation, climate

A dendrochronological network has been established to study the reactions of the European beech (Fagus sylvatica L.) towards the climatic factors. The network includes 21 sampling forest locations that cover the whole elevation range (from 600 m to 1600 m a.s.l.) of the distribution of the beech forests on the Northern slopes of the Balkan Range Mountain, Bulgaria.

The ecoclimatological differentiation of the beech forests is based on cluster analysis of the values of the mean sensitivity and mean tree-ring widths of the dendrochronological series of all 21 sampled forest sites. The ecoclimatological differentiation of the beech forests has been verified by testing linear regression models which describe the changes of the studied factors in respect to the changes of the elevations.

The "climate-growth" relationships have been analysed using response function analyses. Climatic data from six local mountain meteorological stations have been used. The mean temperatures and the amount of precipitations for the months from previous July to current September have been used as predictor variables. The multiple regression calculations have been made for the period 1951–2000.

It has been proved that the European beech forests from the Northern slopes of the Balkan Range Mountain could be divided in two ecoclimatological groups: high mountain beech forests with high dependence on temperatures and low mountain beech forests with limiting dependence of precipitations. The altitudinal border between high and low mountain beech forests can be set at elevation around 1100 m a.s.l.

It has been established that the high mountain beech forests (above 1100 m a.s.l.) are more sensitive to the amount of winter precipitation, than to the amount of summer rainfalls. The temperatures in May and August control the tree-ring formation of the high mountain beech forests.

The amount of the summer precipitations in June, July, August and September has significant importance for the annual diameter increment for the low mountain beech forests (below 1100 m a.s.l.). The high temperatures in the same months play negative role for the tree-ring formation.

The temperature conditions in April are significant for the tree-ring increment for both high and low elevation European beech forests.

It has been proved that the global increase of the air temperature does not lead to permanent reduction of tree-ring widths of the European beech in the Balkan Range Mountain, Bulgaria.

PO10

Taxonomical status and tree-ring chronology building from timber excavated from different archaeological sites in Bulgaria

Dimitrov, Dimitar Petrov[1]; Zafirov, Nikolay[2]; Popov, Hristo[3]; Popova, Tzvetana[3]; Torbatov, Sergey[3]; Katsarova, Vesselka[3]; Borisova-Katsarova, Iliana[4]; Vagalinski, Lyudmil[3]

[1]Forest Research Institute – Sofia, Bulgarian Academy of Sciences
[2]University of Forestry – Sofia
[3]National Archaeological Institute with Museum – Sofia, Bulgarian Academy of Sciences
[4]Sofia University, "St. Kliment Ohridski"
Correspondence: dimitrov_117@abv.bg

Keywords: dendrochronology, archaeology, wood antomy, oak, Roman Empire

Wooden material findings from many archaeological sites in Bulgaria offer excellent opportunities for wood anatomical and dendrochronological research.

In this study we focused on Antique wooden fragments from different constructions discovered in settlements from the Roman Empire period from 1th to 4th centuries AD.

One beam from a bridge construction over a ditch in front of fortress walls, excavated from the Western gate of Serdica (at present city of Sofia), five beams from a building structure from the centre of ancient Serdica and eight wooden samples from the ancient port city of Anhialo (at present town of Pomorie), west Black sea region, have been studied. By using anatomical identification methods, the taxonomical status of all collected timber materials has been identified. It was found that the systematic spectrum of the wooden materials is narrow and contains only species of genus *Quercus* (oaks), subgenuses *Cerris* and *Quercus*. By using dendrochronological methods, floating chronologies were built based on tree-rings widths of the oak samples. Both, graphical comparison via scatter plots, and statistical correlation analysis have been used to test temporal placements and cross-matches of tree-rings among samples.

The constructed oak floating radial increment chronologies will be utilized and incorporated as essential structural components in on-going building of a millennial long master tree-ring chronology for the Eastern Balkan region.

PO11

In situ regeneration and radial growth of Tassili cypress

Fatiha, Abdoun[1]

[1]*Laboratory of Plant Ecology and Environment (LEVE) / Faculty of Biological Sciences (FSB) / USTHB, BP 32 El-Alia 16111 Algeries, Algeria*
Correspondence: fatabdoun@yahoo.fr

Keywords: Cupressus dupreziana A. Camus, hyperarid climate, Sahara, radial growth, regeneration

The cypress of Tassili, unique gymnosperm in the Sahara, arouses great scientific interest in terms of its adaptation to extreme conditions (hyperarid climate). However, the difficult access to the top of the Tassilian massif where it is located makes its observation sporadic. The study of the radial growth of the Tassili cypress in its natural range was started in 1967 by Françoise Serre of the University of Marseille and was taken over in 1997 by us. The discovery of young subjects between 1997 and 1998, we decided to follow their growth. Thus, by updating the inventory of these trees between 2014 and 2019 with the new Tassili Park team, we acquired new data on the speed of their growth. This communication will set out these observations and measures.

References

Abdoun, F., Jull, A.J.T., Guibal, F., Thinon, M., 2005. Radial growth of the Saraha's oldest trees: Cupressus dupreziana A. Camus. Trees : Structure and Function 19, 661–670.

Abdoun, F., Beddiaf, M., 2002. Cupressus dupreziana A. Camus: répartition, dépérissement et régénération au Tassili n'Ajjer, Sahara Central. Comptes rendus Biologie 325, 617–627.

PO12

The effect of the hydromelioration of lowland and highland swamps on the characteristics of forest biogeocoenosis in the middle Urals (Russia)

Fomin, Valery V.[1]; Grigorieva, Alena V.[2]; Gulin, Aleksey N.[3]; Beneva, Eva[4]

[1]GIS-technologies Research Laboratory in Ecology and Forest Sciences, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation
[2]Department of Artificial Stands and Biophysics, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation
[3]Department of Artificial Stands and Biophysics, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation
[4]Department of Forest Botany, Dendrology and Geobiocoenology, Mendel University in Brno, Brno, the Czech Republic
Correspondence: fomval@gmail.com

Keywords: forest hydromelioration, lowland and highland swamp, orest biogeocoenosis, dynamics, Middle Urals, Russia

On the territory of the Ural training and experimental forestry enterprise of the Ural State Forest Engineering University (USFEU, Middle Urals, Russia), the forest hydromelioration polygons were laid in the lowland swamp (65 hectares) in 1976–1977 and in the highland (sphagnum) swamp (120 hectares) in 1988 accordingly. Pure and mixed rpine (*Pinus sylvestris* L.), spruce (*Picea obovata* L.) and birch (*Betula pendula* L.) tree stands grew in the lowland swamp, and pure uneven-aged pine (*Pinus sylvestris* L.) stands grew in the bog. The drainage of these sites was performed by a network of open channels.

There are also significant changes in the growth characteristics of trees and tree stands. It was established that pine stands in the lowland swamp adapt to the changed environmental conditions during the first 5–7 years. In the future their growth improves: the radial increment increases by 3–5 times, the current increment in the stock reaches 4 m^3/ha. Spruce stands react to the drainage more actively. The radial growth of trees increases by 5–7 times from the next or the second year after drainage, the current increase in the stock reaches 6 m^3/ha. The increase in the stock of tree stands on a sphagnum bog, even after draining, is slow with two maximum growths: the first – at the age of 40–50 years, the second – at the age of 70 to 100 years.

PO13

Regulation of bimodal xylem formation pattern in Pinus pinaster saplings

Garcia-Forner, Núria[1]; Vieira, Joana[1]; Nabais, Cristina[1]; Carvalho, Ana[1]; Martínez-Vilalta, Jordi[2]; Campelo, Filipe[1]

[1]Centre for Functional Ecology – Science for People and the Planet, Department of Life Sciences, University of Coimbra
[2]CREAF – Universitat Autònoma de Barcelona
Correspondence: nuria.forner@uc.pt

Keywords: xylogenesis, C uptake and stocks, wood phenology, drought, water relations

Trees' xylem formation encompass large variation in environmental conditions. Abiotic stressors such as warming or drought also modulate plants' behavior. Despite xylem formation susceptibility to carbon and water availability it is still unknown which are the key physiological variables that regulate xylogenesis, and to what extent plants' performance contributes to further explain the number of cells in the different phases of xylem development.

Xylogenesis and physiological behavior was monitored in saplings of Pinus pinaster, distributed in four treatments with contrasting irrigation regimes. Relationships between climate, physiology and the number of cells in the cambium, enlargement and cell-wall thickening phases were evaluated and compared between treatments.

Xylogenesis regulation shifted from physiological to climatic control as cells differentiation advanced to mature tracheids. The number of cells in the cambium increased with assimilation rates and decreased with the water potential gradient through the plant. Enlargement was the most susceptible phase to plants' water content and solubles sugars but no physiological variable contributed to explain the number of cells in wall thickening. All treatments showed a bimodal growth pattern with a second growth period starting when primary growth was completed and after plants had experienced the highest summer hydraulic losses.

Our study demonstrates the importance of including physiological responses and not only climate to fully understand xylogenesis, with special attention to the enlargement phase. This is critical when studying species with a bimodal growth pattern because the second growth peak responds to internal shifts of C allocation and may strongly rely on a lack of hydraulic control and not on a fine tuning of cambial activity with soil water availability.

PO14

Tree-ring studies in Upper Mustang (Nepal). Development of a chronology from Himalayan juniper – chances and limitations.

Gmińska-Nowak, Barbara[1]; Ważny, Tomasz[1]; Tiwari, Achyut[2]

[1]Nicolaus Copernicus University in Toruń, Faculty of Fine Arts, Institute for the Study, Conservation and Restoration of Cultural Heritage, ul. Sienkiewicza 30/32, 87-100 Toruń, Poland
[2]Tribhuvan University, Kathmandu, Nepal
Correspondence: barbara.gminska@gmail.com

Keywords: Upper Mustang, juniper, wedging ring, false ring, density fluctuation

The present state of the dendrochronological exploration of Upper Mustang (Nepal) is fragmentary. The first dendrochronological survey conducted in Upper Mustang in 2015 revealed the need to continue systematic studies on both living trees and historical timbers, and to develop separate Upper Mustang tree-ring chronologies for different species growing in different climatic conditions. The main aim of our study was to develop chronologies for dating of unique architecture of the region, and to enter into discussion on the heritage of the land (the oldest examples of Buddhist architecture: century-old fortresses, palaces, monasteries, temples and houses). Despite of scarcity of natural forest resources in Upper Mustang we found two sites where junipers (*Juniperus recurva*) suitable for dendrochronological research still grows (trees over 150 years old). We collected samples in the forests around the Samar village (14 trees) and from trees found in the neighbourhood of Samdroling (9 trees). To extend the chronology developed from living trees we collected samples of old wood in Samar (16 slices) and we gained great collection of wood from the ancient King Palace in Tsarang (18 pcs). The significant impediments while developing chronology for juniper were numerous missing and wedging rings and false rings (density fluctuations). The most challenging were diverse conditions in which trees grow: exposition, wide range of elevations, local climates differ in temperature and precipitation. Our study will contribute significantly to the reconstruction of the history of settlements and vegetation of Upper Mustang.

Acknowledgement

Research are funded by the National Science Centre, Poland (2013/11/N/HS3/04912).

PO15

Catch the drift: An easy method to quantify sensor related thermal expansion effects on dendrometer measurements

Goisser, Michael Martin[1]; Liu, Jinchen[1]

[1]ECOMATIK e.K.Muenchner Str. 23, 85221 Dachau Germany
Correspondence: goisser@ecomatik.de, liu@ecomatik.de

Keywords: electronic dendrometer, precision dendrometry, diurnal diameter variation, thermal expansion effects

Tree stems archive valuable information and have long been recognized as a meaningful source to investigate past biotic as well as abiotic growth conditions. Bridging the gap between long- and mid-term effects, as recoded in the woody biomass and the plant's response to instantaneous growth conditions, continuous data on tree growth and water status from precision dendrometry has become an important tool to gain a deeper mechanistic understanding of formation and dynamic of the tree ring archive. The absolute magnitude of diameter variations, e.g. related to plant hydration status, however, is very small and thermal expansion effects on dendrometer measurements have to be taken into account. This fact highlights the urgent need for a standardized test method, to ensure verifiability of the technical specifications of different available dendrometer products and, ultimately, the comparability within and between datasets of particular dendrometer studies.

Here we propose a reliable and uncomplicated method to quantify the overall magnitude of temperature effects on dendrometer measurements. Our straightforward test design thereby excludes all other possible sources of uncertainty, such as temperature effects on a measured test body, or temperature dependency of the logging device. Tested were different types of dendrometers with 11 or 25 mm measurement range. Multiple tests were conducted with the dendrometers positioned at 10, 50 and 90% of their respective total measurement range. Testing conditions covered a broad range of different temperatures between –20 to +40 °C. In our test, temperature effects on tested dendrometer models ranged within the same magnitude as stated in the manufacturer's specification sheets.

PO16

Features of the formation of larch and birch tree stands in the mountains of the subpolar Urals in the conditions of climate change

Grigoriev, Andrey A.[1]; **Nagimov, Zufar Ya.**[1]

[1]*Department of Forest Dedrometry and Forest Inventory, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation*
Correspondence: lxf@usfeu.ru

Keywords: upper tree line ecotone, upward shift, Larix sibirica Ledeb, Betula pendula Roth, Subpolar Urals

Over the past 120 years, the climate in the Subpolar Urals has become warmer (0.6–0.8 °C) and more humid (the average annual rainfall has increased by almost 30%). The most significant increase in surface air temperature and rainfall occurred in the winter months. The upper boundary of woody vegetation is shifted to higher places along the high-altitude gradient. This fact is confirmed by the repeated landscape photographs taken in different years and the characteristic of tree stands.

On different slopes the advancement of woody vegetation to the mountains proceeds with unequal intensity, which is determined by the local site conditions. Larch (*Larix sibirica* Ledeb) and birch (*Betula pendula* Roth) trees have different reactions to the thickness of snow cover and the degree of soil freezing. The upward shift of the upper tree line started form larch (as a pioneer) in the snowy areas (at the end of the 18th century). Settling of little snowy areas by larch trees began only in the 20th century. Birch trees became popular later (at the beginning of the 20th century) and are actively strengthening its position in the present. The larch and birch stands that have been formed at different altitudinal levels of the upper tree line ecotone (UTLE) are completely uneven-aged. The structure of the tree stands that have been formed in UTLE substantially depends on their altitude position: with increasing of altitude, trees with the same diameter value have the smaller height, the length of the crowns, and the larger diameter of crown.

PO17

Dendrochronological analysis of „Hungarian" medieval paintings

Grynaeus, András[1]

[1]*Hungarian Dendrochronological Laboratory – Cincér Bt., Széher út 76/a, 1021 Budapest, Hungary*
Correspondence: dendro@ludens.elte.hu

Keywords: medieval paintings, Hungary, dating, Christian Museum of Esztergom

The dendrochronological research plays an important role in Europe for the study of dated art works, paintings, sculptures and furniture. In Hungary, although with considerable delay, but in the 1990s, regular dendrochronological research began, nevertheless, these did not cover artistic works. The first article dealing with the dendrochronological dating of the medieval Hungarian panel paintings was published only in 2014. This situation is partly due to the fact that the great medieval and early modern wars, i.e. the Ottoman occupation and the seventeenth-century reconquest of the kingdom led by combined European armies, inflicted serious damage in the memories. Those areas (in the northern and eastern part of the Carpathian Basin) that have been spared, became part of other countries in the early 20th century.

In early 2019, art historians, restorers and dendrochronologists began the first systematic and thought-out series of dendrochronological studies to fill this lag and to reveal new insights offered by such interdisciplinary studies. The scene of the project was the collection of the Christian Museum of Esztergom.

During the research, we have faced the specificities of the materials and the resulting difficulties. On the one hand, part of the material of the collection is not of Hungarian provenience but got into the collection in the 19th century when they were bought on the international art market (that is why there is a quotation mark in the title). Obviously, the dating of these works is important for art historians, but they do not contribute to the dendrochronological database in Hungary. On the other hand, some of the works of art became unresearchable due to the earlier restorations, for example by gluing them on a modern wood sheet. Thirdly, we also faced the difficulties that old masters used a variety of wood species and saw the consequences of the use of poorer-quality or younger wood.

What can be the result of such a research? One can get precise points of reference for to confirm or not the dating by art historians; one can prove or disprove the connection of single works that had been separated; and one can gain valuable information about the place of production and the quality of work.

References

Klein, P., 1985. Dendrochronologische Untersuchungen an Gemäldetafeln und Musikinstrumenten, Dendrochronologia 3, 25–44.

Tóth, B., Botár, I., Grynaeus, A., 2012, A csíkszentdomokosi „Mária megkoronázása" táblakép dendrokronológiai vizsgálata. (The dendrochronological analysis of the central panel ‚Coronation of the Virgin' from Sânominic.) A Csíki Székely Múzeum Évkönyve VIII. 151–158.

PO18

The effect of temperature on wood formation and phenology of oak along two altitudinal gradients under Atlantic climate

Guada, Guillermo[1]; Vázquez-Ruiz, Rosa Ana[1]; García-González, Ignacio[1]

[1]Universidade de Santiago de Compostela, Departamento de Botánica, EPSE, Campus Terra, Lugo, 27002 Spain
Correspondence: ignacio.garcia@usc.es

Keywords: budburst, cambium, Quercus robur, ring-porous wood, xylogenesis

Monitoring of wood formation is one of the most useful techniques for the interpretation of the cause-effect relationships of climatic responses observed in dendrochronological series. However, most of the work carried out so far focuses on conifers, mainly in cold climates, while deciduous species of temperate latitudes have poorly studied.

In order to better understand the role of climate on xylogenesis, we selected nine sites along two elevational gradients from the coastline in northwestern Iberia, and randomly sampled ten oak trees per site biweekly during 2012 and 2013. Leaf and cambial phenological phases were related to mean air temperature for several running periods along the year to identify the most relevant time windows for cambium and leaf phenophases, and the relationships among them. Our objective was to delve into understanding how temperature variation affects primary and secondary growth in oak, especially during the early growing season.

The first earlywood vessels expanded before the appearance of small leaves, and subsequently underwent maturation to meet water requirements for full leaf unfolding, confirming that the maturation of the first elements is necessary to complete the development of the new leaves. The advance or delay of cambial reactivation and budburst varied among sites and years modulated by spring temperature, and were respectively maximized by maximum and minimum values. However, temperature can modify the onset of early phenophases of primary and secondary growth differently, thus affecting the synchronicity between them.

PO19

Influence of site conditions and stand structure on basic density of stemwood of Silver birch (Betula pendula Roth.)

Hauserová, Eliška[1]; Vavrčík, Hanuš[1]; Fajstavr, Marek[1]; Sendecký, Matúš[2]; Balková, Marie[3]; Martiník, Antonín[2]

[1]Department of Wood Science, Faculty of Forestry and Wood Technology, Mendel University in Brno
[2]Department of Silviculture, Faculty of Forestry and Wood Technology, Mendel University in Brno
[3]Department of Geology and Pedology, Faculty of Forestry and Wood Technology, Mendel University in Brno
Correspondence: vavrcik@mendelu.cz

Keywords: Silver birch, basic density, site conditions, stand structure

The main aim of this study was to find out variations within wood densities of silver birch stems depending on the site conditions and stand structure. The surveys were made in four forest stands in two regions of the Czech Republic. Experimental stands (plots) with high proportion of silver birch were different in age and also in diameter structure. Wood cores were taken by means of Pressler increment borer for the tree-ring width analysis and for determination of basic density. Percentage of green crown was evaluated for each sampled tree.

There was no statistically significant difference in means and variances ($\alpha = 0.05$) among plots. It was proved that diameters did not show homogeneity among plots. There were statistically significant differences in means of diameter at breast height at least between two plots and in means of tree-ring width among all plots excluding one.

No dependency between density and diameter at breast height was proved ($R2 = 0.07$). Moreover relations between wood density and age or percentage of green crown showed low values of coefficients of determination (R2): 0.08 and 0.04, respectively. It seems that density of wood is not dependent on tree diameter, age or mean tree-ring width for silver birch.

Acknowledgement

This study was supported by Internal Grant Agency (IGA), a project under the grant LDF_PSV_2018002.

PO20

Piloting the development of new alpine hydroclimate records from southeastern Australia using wood properties

Henley, Benjamin J.[1]; Allen, Kathryn[2]; Evans, Robert[2]; Brookhouse, Matthew[3]; Spiers, Johanna[4]; Baker, Patrick[5]; Peel, Murray C.[6]

[1]School of Earth Sciences, University of Melbourne, Australia; Infrastructure Engineering, Melbourne School of Engineering, University of Melbourne, Australia; School of Earth, Atmosphere and Environment, Monash University, Australia
[2]School of Ecosystem and Forest Sciences, University of Melbourne, Australia
[3]Fenner School of Environment and Society, Australian National University
[4]Snowy Hydro Limited
[5]School of Ecosystem and Forest Sciences, University of Melbourne, Australia
[6]Infrastructure Engineering, Melbourne School of Engineering, University of Melbourne, Australia
Correspondence: benjamin.henley@unimelb.edu.au

Keywords: wood properties, tree-rings, hydroclimate, Eucalyptus, Podocarpus

Short instrumental records make characterising Australian hydroclimatic variability difficult and limit the ability to adequately plan and manage water-resources allocations for urban and rural water supply, agriculture, and hydroelectric power generation. Tree-ring records provide a means to extend records back in time, however, there are few such records of more than 200 years from the Australian mainland. Eucalyptus species dominate the Australian mainland and few of those that have been investigated reliably exhibit annual growth rings. There are, however, promising signs that specialised methods can be used on some species in specific locations to yield crossdatable chronologies that are sensitive to hydroclimate. This study assesses the potential for developing multi-century hydroclimate proxy records from the wood properties of Eucalyptus niphophila (snow gum) and Podocarpus lawrencei (mountain plum pine) using an image analyser, X-ray densitometer, and X-ray diffractometer from SilviScan-3. We measure cell cross-sectional dimensions, density, micro-fibril angle, cellulose crystallite size, wood stiffness and fibre orientation, and compare these wood properties to hydroclimate data from alpine regions in southeastern Australia. Our initial investigations show some encouraging signs for some of these wood traits. These investigations target a strategic knowledge gap about past rainfall and streamflow variability in southeastern Australia. Filling this knowledge gap would provide new insights into the long-term context for recent and projected changes in rainfall and streamflow with substantial anticipated benefits for stakeholders in the Australian water, hydroelectricity, environmental and agricultural sectors.

PO21

Influence of climate on radial growth of atlas pistachio in Algeria according to a gradient of aridity

Ifticene-Habani, Naima[1]

[1]*University Algiers 1. Faculty of Sciences. Department of Science of Nature and Life, 02, Didouche Mourad,16000, Algiers, Algeria*
Correspondence: naimaifticene@hotmail.com

Keywords: Atlas pistachio, radial growth, dendroecology, sensitivity, climate

The distribution range of the Atlas pistachio tree in North Africa extends from the Maritime Atlas mountains, where it is found together with Atlas cedars, to the central Sahara where it grows with acacias. The species is of particular ecological and biogeographical interest as its association with other characteristic species of arid, semi-arid and subhumid habitats point to a high degree of resistance to global changes, especially climate change. Indeed, its presence in these regions where conditions are extreme remains an enigma. In our study, we tried to answer the question of why and to what extent, the climate could constitute a limiting factor.
The dendroecological study conducted in three bioclimatic regions (arid, semi-arid and subhumid) targeted six stations. The main objective is to highlight the climatic factors governing the radial growth „the ring“ of this species.
The results obtained show that the ring width of the Pistacheriae in the subhumid is substantially greater than that in the arid and semi-arid regions. Thus, the stationary peculiarities induce differential variations in the intensity of the reaction of trees to environmental factors that fluctuate from one year to another. The response of the Atlas pistachio tree to climatic variability is clearly shown by high average sensitivity coefficients obtained in the arid and semi-arid regions.
The response-function analysis, shows the major role of rainfalls in the determinism of the radial growth for the three regions, whereas, the temperatures effect is complementary. The biotope plays a major role in the ring-climate relationship.

References

Ifticene-Habani, N., Messaoudène, M., 2016. Croissance radiale et sensibilité au climat du pistachier de l'Atlas, Pistacia atlantica Desf., en Algérie. Bois et Forêts des Tropiques 329, 3–15.
Mérian, P., 2012. POINTER et DENDRO: deux applications sous R pour l'analyse de la réponse des arbres au climat par approche dendroécologique. Revue Forestière Française 64, 789–798.
Stokes, M. A., Smiley, T. L., 1968. An introduction to tree ring dating. The University of Chicago Press, Chicago, 73 pp.

Acknowledgement

We would like to pay homage to the initiator of this work the late Mahand Messaoudène, Research Director at the National Institute Forestry Research, Regional Station Azazga, Tizi Ouzou, Algeria.We thank Mohamed Said Guettouche, Director of the Laboratory of Geography and Territorial Planning (USTHB), for his help in applying the program R.

PO22

The growth dynamics of the stone pine (Pinus cembra L.) in cliff forest of the Tatra Mountains

Izworska, Katarzyna[1]; Zielonka, Tomasz[1]

[1]Pedagogical University of Cracow, Institute of Biology, ul. Podchorążych 2, 30-084 Kraków, Poland
Correspondence: katarzynaizworska@gmail.com

Keywords: Cliff forest, Dendroecology, Pinus cembra, Tatra Mountains

The aim of this study was to determine the age structure and the dynamics of a radial growth of stone pines (*Pinus cembra* L.) growing in cliff forest in the Tatra Mountains in the Western Carpathians. The cliff forests are a unique type of forest ecosystems regarded as pristine and extreme habitats. The stone pine is a tree species which exhibits the best adaptation to colonise and successfully growth in such an environment. We collected 102 cores from living trees and 6 cores from freshly dead snags. Trees were sampled randomly within the altitude of 1350–1550 m asl. The cores were sanded, scanned with a high resolution and the tree-ring widths were measured with WinDendro programme. The preliminary, visual cross-dating was done during measurements using pointer years. The quality of cross-dating was confirmed with Cofecha. The ages of the trees were determine using the pith year. If the inner part of the stem was rotten, but the position of pith could be estimated, we extrapolated the number of rings to the pith. Tree-ring chronology was tested for its relationship with climatic data. Long term growth trend were analysed using the percent growth change analyses. The oldest pine was 436 years old and the youngest one was 64 years old. The oldest trees exhibited very slow growth. An abrupt growth releases were observed in some portions of tree-ring series. This may indicate that growth of stone pine in Tatra's cliffs is not controlled exclusively by climate, but also by external disturbances.

Acknowledgement

The study was supported by the NCN project no N N309 711240.

PO23

Intra-annual xylem growth of prince rupprecht larch at its upper and lower distribution limits on the Luyashan mountain in north-central China

Jiang, Yuan[1]**; Kang, Muyi**[1]

[1]*Beijing Normal University, Faculty of Geographic Science, College of Natural Resources, Xinjiekouwai Str. 19, Beijing 100875, China*
Correspondence: kangmy@bnu.edu.cn

Keywords: treeline, cell differentiation, xylogenesis, elevational gradient, threshold temperature

Altitude-related climatic factors, especially temperature, are important factors that affect tree growth in mountain forest ecosystems. The aims of this study were to estimate the intra-annual radial growth differences of *Larix principis-rupprechtii* (Prince Rupprecht Larch) between its upper and lower distribution limits, at 2740 and 2040 m a.s.l, respectively. Dynamics of xylem growth were observed by collecting microcore samples weekly during the 2011 growth season. The result indicated that different strategies were adopted at the two selected sites. Trees at the upper distribution limit adopted an "intensive strategy" with higher maximum growth rates (0.69 cell·day^{-1}) within a shorter duration of 95 days, producing 21 new tracheids. By contrast, trees at the lower distribution limit exhibited an "extensive strategy" with lower maximum growth rates (0.53 cell·day^{-1}) over a longer duration of 135 days, producing 50 tracheids. The soil temperature was probably the main factor limiting the onset of cambial activity for the Larch, its daily mean thresholds for onset were 0 °C and 1.4 °C at the upper and lower distribution limits, respectively. These results indicate that this Larch is able to adjust its xylem growth according to environmental conditions.

References

Rossi, S., Morin, H., Deslauriers, A., Plourde, P.-Y., 2011. Predicting xylem phenology in black spruce under climate warming. Global Change Biology 17, 614–625.

Rossi, S., Deslauriers, A., Morin, H., 2003. Application of the Gompertz equation for the study of xylem cell development. Dendrochronologia 21, 33–39.

Leng, W.F., He, H.S., Liu, H.J., 2008. Response of larch species to climate changes. Journal of Plant Ecology 1, 203–205.

PO24

Early monsoon failure and mid-summer dryness induces growth cessation of lower range margin Picea crassifolia

Kang, Muyi[1]; Jiang, Yuan[1]; Zhao, Shoudong [1]

[1]Beijing Normal University, Faculty of Geographic Science, School of Natural Resources, Beijing 100875, China
Correspondence: jiangy@bnu.edu.cn

Keywords: tree-ring analysis, semi-arid Asia, climate change, locally absent rings, species range margins

Extreme climatic events are increasingly recognized as important drivers of tree growth, forest dynamics, and range contractions. Understanding tree growth responses to extreme events is important for forest conservation and management, especially under climate change. Here, we studied the patterns of growth cessation of *Picea crassifolia* Kom., an endemic species to Central Asia, across its distributional range in the Helan Mountains of Northwestern China, to test the hypotheses that (1) tree growth and growth cessations are limited by moisture availability, and (2) that this relationship is constant over the diverse set of conditions covered in our elevational gradient. While tree growth across our gradient was significantly limited by low precipitation in June, we found growth cessation events at the lower distributional margin to increase in severity and frequency in recent decades. We found that the combination of low precipitation early in the monsoon season (June) and high mid-summer (July) vapor pressure deficit likely caused the increased frequency of growth cessation events. Because these populations are already experiencing a high frequency of growth cessation events, the mortality rate of the lower distributional margin trees could further increase if the current trends of decreasing moisture and increasing heat stress continue into the future. Our results strongly suggest that growth cessation events are more than the dendrochronological curiosity they are usually considered to be, and can be important indicators of increased tree growth stress and be potentially useful in identifying tipping points prior to forest change.

Acknowledgement

This work was supported by the National Natural Science Foundation of China (NSFC no. 41630750 and no. 41771051). We are very grateful to Hui Wang and Jingfan Wang for their help during fieldwork.

PO25

Introducing a new approach for assessing the temporally variable reconstruction reliability of tree-ring chronologies

Karanitsch-Ackerl, Sandra[1]; Mayer, Konrad[1]; Holawe, Franz[2]; Grabner, Michael[1]

[1]University of Natural Resources and Life Sciences, BOKU Vienna, Department of Material Sciences and Process Engineering, Institute of Wood Technology and Renewable Materials, Konrad-Lorenz-Straße 24, 3430 Tulln an der Donau, Austria
[2]University of Vienna, Faculty of Earth Sciences, Geography and Astronomy, Department of Geography and Regional Research, Althanstraße 14, 1090 Vienna, Austria
Correspondence: sandra.karanitsch@boku.ac.at

Keywords: dendroclimatology, EPS, prediction interval, uncertainty, scaling factor

That changing replication "can make calibration-period statistics misleading as measures of accuracy of long-term reconstructions" (Stockton and Meko, 1983) has been observed and communicated by dendroclimatologists for many years. To account for the increasing uncertainty with decreasing replication, an adapted EPS based on Wigley et al. (1984) and Mérian et al. (2013) is used to define an empirical scaling factor for estimating a prediction interval (PI) of the reconstructed time series. The approach is applied on a precipitation reconstruction back to 1600 with latewood chronologies from north-eastern Austria (linear regression, $R^2 = 0.47$).

In a regression framework, a classical PI assumes constant error variances over time. However, the common signal (EPS) and noise (1-EPS) is not constant over the chronology's extent. By rescaling the squared residual standard error with the factor [(1-EPSt)/(1-EPScal)] differences in the error variances of the individual reconstructed years (t), compared to the calibration period (cal) are addressed. The scaling factor is >1/<1 in years with more/less noise contained in the chronology compared to the calibration period and widening/narrowing the approximative PI.

Based on the two well-known and widely accepted concepts of PIs and EPS, the rescaled PI enables to see the changing confidence over time when plotting it with the reconstruction, but it is unclear, whether the chosen scaling factor is the most suitable one or if it over-/underestimates the increase of uncertainty with decreasing EPS. Other scaling factors as well as alternative approaches to address the reliability of tree-ring reconstructions need to be further investigated.

References

Mérian, P., Pierrat, J.-C., Lebourgeois, F., 2013. Effect of sampling effort on the regional chronology statistics and climate–growth relationships estimation. Dendrochronologia 31, 58–67.

Stockton, C.W., Meko, D.M., 1983. Drought recurrence in the Great Plains as reconstructed from long-term tree-ring records. Journal of Climate and Applied Meteorology 22, 17–29.

Wigley, T.M.L., Briffa, K.R., Jones, P.D., 1984. On the average of correlated time series, with applications in dendroclimatology and hydrometeorology. Journal of Climate and Applied Meteorology 23, 201–213.

PO26

Changes in radial growth of Fagus sylvatica L. due to creep in flysch zone of the Carpathians, Czech Republic

Kašpar, Jakub[1]; Šamonil, Pavel[1,2]; Krůček, Martin[1]; Kral, Kamil[1]; Egli, Markus[3]

[1]The Silva Tarouca Research Institute, Dep. of Forest Ecology, Lidicka 25/27, 602 00 Brno, Czech Republic
[2]Mendel University in Brno, Faculty of Forestry and Wood Technology, Dep. of Forest Botany, Dendrology and Geobiocoenology, Zemědělská 3, 613 00 Brno,
[3]University of Zurich, Dep. of Geography, Winterthurerstrasse 190, 8057 Zurich, Switzerland
Correspondence: pavel.samonil@vukoz.cz

Keywords: dendrogeomorphology, hillslope processes, laser scanning, radiometry, beech

We focused on the detection of the soil creep in radial growth of beech trees in the flysch zone of the Carpathians, Czech Republic. In Razula Reserve we cored 230 trees at a height of 0.5 m on an area of about 2 hectares and we evaluated their radial growth in 4 directions (along contour lines and slope). Growth eccentricity at the scale of individual tree rings and the occurrence of reaction wood were assessed. In order to filter out the effect of competition, disturbance history of tree layer was studied as well. We dealt with the manifestation of the biomechanical effects of the trees in soil. Hypothetically, we assumed that trees with bent base strains exhibit higher eccentricity and creep. At the same time, we dealt with the ability of trees to stabilize slope processes. These were examined independently by repeated terrestrial laser scanning. Rate of slope denudation was studied by radiometric methods (Pu and Be isotopes). We installed 5 creep cons to visualize soil movement.
Eccentricity was observed in all directions of tree growth. Its source along contour lines was mainly competition related to forest gap dynamics. Creep was pronounced in the direction of the slope. Trees of DBH = 10–15cm showed maximum eccentricity. With increasing tree diameter eccentricity decreased to ca 40cm. Then it grew again, probably due to root swelling. Changes in eccentricity are probably related to the ability of trees to stabilize slope. The continuous creep component was more pronounced than its instantaneous dynamic component.

References

Pawlik L., Šamonil P., 2018. Soil creep: the driving factors, evidence and significance for biogeomorphic and pedogenic domains and systems – a critical literature review. Earth-Science Reviews 178, 257–278.
Phillips J.D., Šamonil P., Pawlik L., Trochta J., Daněk P., 2017. Domination of Hillslope Denudation by Tree Uprooting in an Old-Growth Forest. Geomorphology 276, 27–36.
Šilhán, K., 2012. Dendrogeomorphological analysis of evolution of slope processes on flysch rocks (the Vsetínské vrchy Mts; Czech Republic). Carpathian Journal of Earth and Environmental Sciences 7, 39–49.

Acknowledgement

The research was supported by Grantová Agentura České Republiky (the Czech Science Foundation), project No.19-09427S.

PO27

Early Iron Age floating oak chronology from Eresztvény Forest (Fehérvárcsurgó, Hungary)

Kern, Zoltán[1]; Jungbert, Béla[2]; Horváth, Emil[3]; Molnár, Mihály[4]; Morgós, András[5]

[1]Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences, MTA, Budaörsi út 45, H-1112 Budapest, Hungary
[2]H-8000, Székesfehérvár, Poprádi utca 36.
[3]H-8051 Sárkeresztes, Kölcsey Ferenc u. 53
[4]Isotope Climatology and Environmental Research Centre (ICER), MTA ATOMKI, Bem tér 18/c, Debrecen, Hungary
[5]Consart, H-1124 Budapest, Kálló esperes u. 1.
Correspondence: zoltan.kern@gmail.com

Keywords: dendroarchaeology, Quercus, radiocarbon, Hallstatt Culture, Hungary

Archaeological excavations unearthed three burial mounds between 1983 and 1986 in the Eresztvény Forest (Fehérvárcsurgó, Fejér County, Hungary). Based on the archaeological classification of the found objects an Early Iron Age (Hallstatt C) age was assigned to them. Although large amount of wooden remains were recovered from the tumuli dendrochronological analysis has not been performed on the material at that time. Unfortunately, only a small portion of the wooden remains have been preserved. Five disk samples were collected from the preserved beams and used for dendrochronological analysis. The species of each sample is sessile oak (*Quercus petraea*) based on the wood anatomical characteristics. Counted rings ranged from 49 to 131. The tree-ring width sequences of the four longest records were successfully synchronized and a 151-yr-long floating chronology was obtained. Small blocks, containing 4 to 7 annual increments, were detached from three disks and α-cellulose was separated. Measured targets are prepared using sealed-tube graphitization method (Rinyu et al., 2013). Radiocarbon analysis will be performed at the ICER Centre (Debrecen, MTA ATOMKI) using the EnvironMICADAS facility (Molnár et al., 2013).

References

Molnár, M., Rinyu, L., Veres, M., Seiler, M., Wacker, L., Synal, H.A., 2013. EnvironMICADAS: a mini 14C-AMS with enhanced gas ion source interface in the Hertelendi Laboratory of Environmental Studies (HEKAL), Hungary. Radiocarbon 55, 338–344.

Rinyu, L., Molnár, M., Major, I., Nagy, T., Veres, M., Kimák, Á., Wacker, L., Synal, H.A., 2013. Optimization of sealed tube graphitization method for environmental 14C studies using MICADAS. Nuclear Instruments and Methods in Physics Research B 294, 270

Acknowledgement

The research was supported by the European Union and the State of Hungary, co-financed by the European Regional Development Fund in the project of GINOP-2.3.2.-15-2016-00009 'ICER' and LP2012-27/2012.

PO28

Pollution control in the 1980s contributed to unprecedented spruce growth in the "Black Triangle", the Czech-Polish border region

Kolář, Tomáš[1,2]; Čermák, Petr[3]; Oulehle, Filip[2,4]; Trnka, Miroslav[2,5], Štěpánek, Petr[2,6]; Cudlín, Pavel[2]; Hruška, Jakub[2,4]; Büntgen, Ulf[2,7,8,9]; Rybníček, Michal[1,2]

[1] Department of Wood Science and Technology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic
[2] Global Change Research Centre, Academy of Science of the Czech Republic v.v.i, Bělidla 986/4a, 603 00 Brno, Czech Republic
[3] Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic
[4] Department of Biogeochemistry, Czech Geological Survey, Klárov 3, 118 21 Prague, Czech Republic
[5] Department of Agrosystems and Bioclimatology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[6] Czech Hydrometeorological Institute, Regional Office Brno, Brno, Czech Republic
[7] Department of Geography, University of Cambridge, Cambridge CB2 3EN, UK
[8] Swiss Federal Research Institute WSL, Birmensdorf, Switzerland
[9] Department of Geography, Masaryk University, 611 37 Brno, Czech Republic.
Correspondence: koldatom@gmail.com

Keywords: air pollution, Central Europe, dendroecology, forest growth, Norway spruce

Norway spruce (*Picea abies* (L.) Karst.) stands across Central Europe experienced substantial dieback in the 1970s, likely as a result of complex interactions between SO_2 emissons, drought spells, insect and pathogen outbreaks, and soil acidification. However, quantifying and fully understanding all reasons for the decline in forest health was complicated by a general lack of long and well replicated tree-ring chronologies. Moreover, it remained mostly unexplored if and how forest ecosystems responded to the drastic pollution controls that were initiated in the early-1980s. Here, we evaluate the long-term behaviour of an annually resolved and absolutely dated network of spruce ring width chronologies from the Czech-Polish border, a sub-alpine area that was heavily affected by acid deposition at the turn of 1980s. Tree-ring width measurements from 123 trees resulted in the long-term well replicated chronologies represented different parts of the region between 900 and 1350 m asl. All sites above 1000 m asl show a close relationship between tree-ring widths and May-July temperatures. However, temporal instability in the relationship reveals the strong influence of the sulphur deposition on the tree growth and reduces usability of the chronologies for climate reconstructions. The sulphur emission control since the 1980s, accompanied by a recovery of forest ecosystems, enables unusual growth increase of spruce stands across Central Europe. An integrated impact resulting from many factors entails the high productivity of Central European forest ecosystems.

Acknowledgments

The study was supported by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415 and the Czech Science Foundation through the grant numbered 18-17295S.

PO29

Reconstruction of the Holocene palaeoclimatic changes on the basis of subfossil peatland trees' dendrochronology and peat stratigraphy: the Puścizna Wielka raised bog (Polish Western Carpathians) related to selected peatlands of the Northern Poland

Krąpiec, Marek[1]; Szychowska-Krąpiec, Elżbieta[1]; Barniak, Joanna[1]

[1]AGH University of Science and Technology, A. Mickiewicza Ave. 30, 30-059, Kraków, Poland
Correspondence: mkrapiec@agh.edu.pl

Keywords: dendrochronology, subfossil wood, Pinus sylvestris, climate change, raised bog

Dendrochronological analysis of subfossil pine trees buried in the peat of the Puścizna Wielka raised bog (Polish Western Carpathians, Southern Poland), indicate that the pine tree populations grew in this peat bog in between ca 5415–2560 cal. BP. However, the periods of pine forest development were separated by several forestless episodes, dated to 5245–5155 cal. BP, 4525–4395 cal. BP and 3940–3050 cal. BP (Krąpiec, Szychowska-Krąpiec 2016, Krąpiec et al. 2016). These deforestations were preceded by tree dying–off phases caused by the climate humidity growths and coolings. These climatic changes were reconstructed on the base of dendrochronological analyses of the trees, as well as a multi proxy peat sediment analysis, and radiocarbon datings. The last forestless period began about 2.6 ka cal BP. Similar dying-off phases were dendrochronologically detected ca 2.7 ka cal BP in the Rucianka peat bog in the Polish Lowland, which has accumulated since ca 3.3 ka cal BP. Preliminary results of pine bog dendrochronology and peat analyses in the other peatlands of the Northern Poland: Budwity and Józefowo peatlands, formed since ca 9.0–8.5 ka cal BP, allowed us to refer the tree dying-off episodes to the Early Subatlantic climate humidity growths and cooling at ca 2.7 ka cal BP in the Józefowo, at ca 3.5 ka cal BP and 2.8 ka cal BP in Budwity (unique death forest horizon exposed due the peat excavation). These subfossil bog-pine analyses are sensitive indicators of climate humidity fluctuation in the Polish territory during the Holocene.

References

Krąpiec, M., Szychowska-Krąpiec, E., 2016. Subfossil bog-pine chronologies from the Puścizna Wielka raised bog, Orawa Basin, southern Poland. Quaternary International 415, 145–153.

Krąpiec, M., Margielewski, W,. Korzeń, K., Szychowska-Krąpiec, E., Nalepka, D., Łajczak, A., 2016. Late Holocene palaeoclimate variability the significance of bog pine dendrochronology related to peat stratigraphy: the Puścizna Wielka raised bog case study (Orawa – Nowy Targ Basin, Polish Inner Carpathians). Quaternary Science Reviews 148, 192–208.

PO30

Dendrochronologically dated stringed instruments from Estonia

Läänelaid, Alar[1]; Sohar, Kristina[1]; Toomik, Sandra[1]

[1]University of Tartu, Institute of Ecology and Earth Sciences, Department of Geography, Vanemuise 46, 51003 Tartu, Estonia
Correspondence: alar.laanelaid@ut.ee

Keywords: dendrochronological dating, stringed instruments, Estonia

Following the long tradition of dendrochronological investigation of musical instruments in Europe (Wilson and Topham, 2004; Beuting, 2011; Čufar et al. 2017), we have dated thirty stringed instruments by their tree rings. Most of them show a more or less similar course of tree-ring widths, referring to the same region of provenance of the wood. In some cases tree-ring measurements on the belly were hindered due to dark wood stain and/or patina. In some cases wood fissures and varnish cracks obscured the ring borders, causing measurement mistakes. The tree-ring series of the dated violins are analysed for their time period and length of the series, similarity rates, provenance region and average ring widths. In spite of different history of the instruments, the tree-ring series of them often show a common provenance region of the wood. We can conclude that Estonia had vivid trade relations with the violin making regions of central part of Europe already a hundred and more years ago.

References

Beuting, M., 2011. Dendro-organology? The dendrochronological method applied to musical instruments. In: Fraiture, P. (Ed), Tree Rings, Art, Archaeology. Proceedings of an International Conference. Brussels, p. 273–283.

Čufar, K., Beuting, M., Demšar, B., Merela, M., 2017. Dating of violins – The interpretation of dendrochronological reports. Journal of Cultural Heritage 27, S44–S54.

Wilson, R., Topham, J., 2004. Violins and climate. Theoretical and Applied Climatology 77, 9–24.

PO31

Bosnian pine tree-ring width chronology in the subalpine belt of the southeastern Dinaric Mountains – preliminary results

Lukac, Ljubica[1]

[1]*University in Zagreb, Faculty of Forestry, Dep. of Silviculture*
Correspondence: lukac.ljubica@gmail.com

Keywords: Pinus heldreichii, tree ring chronology, Dinaric Mountains

Our study area is on the Orjen mountain in the Bosnia and Herzegovina and Montenegro where the primeval forest of Bosnian pine is located. The climate in the southeastern Dinaric Mountains is typical for mountainous region but it is also strongly influenced by Mediterranean climate and humidity.
Old and healthy stems were selected for sampling. Two cores from opposite sides were taken from each tree. Samples were scanned using ATRICS system and further processing of data was done by TSAP-Win™ programme and quality checked with COFECHA. This steps were used to build sites chronology and regional chronology. We compared standard chronologies for each site with mean monthly temperatures and the monthly sum of precipitation from the previous September to the current October in order to detect potential differences in tree growth in relation to the climate. Climate data was taken from KNMI Climate Explorer.
Our goal was to show dynamics of natural disturbances and their impact on tree growth. We constructed 640-year long Pinus heldreichii chronology. Reliable chronology for climate reconstruction for Pinus heldreichii is from 1697 to 2016 (EPS >0.85). According to climate correlations strong relationship was found between tree-ring indices and precipitation from September of the previous year and June–July of the current year. Negative impact of temperature in June of the current year was detected for *Pinus heldreichii* from Orjen. According to Palmer drought–severity index (PDSI) Bosnian pine is sensitive to drought in September and October. These results will contribute to more reliable proxy climate records for the region.

References

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 24, 479–490.
Levanič T., Popa I., Poljanšek S., Nechita C. 2012. A 323-year long reconstruction of drought for SW Romania based on black pine (Pinus nigra) tree-ring widths. International Journal of Biometeorology, 1–12.
Seidl, R., Thom, D., Kautz, M., Martin-Benito D., Peltoniemi, M., Vacchiano, G., Wild, J., Ascoli, D., Petr, M., Honkaniemi, J., Lexer, M.J., Trotsiuk, V., Mairota, P., Svoboda, M., Fabrika, M., Nagel, T.A., Reyer, Ch.P.O., 2017. Forest disturbances under climate change. Nat Clim Change 7, 395–402.

PO32

Tracheid size and cell wall thickness of some provenances of Scote pine in Latvia

Matisons, Roberts[1]; Elferts, Didzis[1,2]; Jansons, Aris[1]; Gartner, Holger[3]

[1]LSFRI Silava, Rigas 111, Salaspils, Latvia
[2]University of Latvia, Faculty of Biology; Jelgavas 1, Riga, Latvia
[3]WSL, Zuricherstrasse 111, Birmensdorf ZH, Switzerland
Correspondence: robism@inbox.lv

Keywords: quantitative wood anatomy, experimental forestry, provenance trial, tracheid size, forest adaptation

Under warming climate, availability of water in summer is emerging as an important issue for tree growth also in the boreal and hemiboreal forests. Considering importance of Scots pine (*Pinus sylvestris* L.) in Northern Europe and non-promising predictions for its performance, numerous efforts have been made to improve resilience of the species. Scots pine has wide distribution range, hence selection among its provenances has been mentioned among the most effective means for sustain productivity. Susceptibility of trees to water deficit at least partially can be anticipated from their wood anatomy. In this study, differences in tracheid lumen area and cell wall thickness among Northern European provenance of Scots pine were assessed. Studied provenances differed by lumen area both in earlywood and latewood, while differences in cell wall thickness were less pronounced. The bottom performing provenances (Dippoldiswalde and Eibenstock, which originated from the Orr Mountains) had the smallest lumen area of tracheids, suggesting less efficient water transport. In contrast, the top-performing provenances (Gustrow and particularly Rytel, which originated from lowland regions in Poland and Northern Germany) showed the highest lumen area of tracheids. Nevertheless, larger tracheids also imply higher possibility of embolism, particularly under warming climate. The studied anatomical proxies showed relation with climatic factors before and during their formation. Formation of earlywood was affected by temperature, while latewood anatomy showed correlation with precipitation. The correlations with climatic factors differed among the provenances, suggesting varying response to changing climate.

Acknowledgement

This study was funded by European Regional Development Fund.

PO33

Wood rays in tree-rings of Scots pine

Matisons, Roberts[1]; Dubra, Stefanija[1,2]; Dauškane, Iluta[2]; Elferts, Didzis[1,2]; Jansons, Aris[1]; Gartner, Holger[3]

[1]LSFRI Silava, Rigas 111, Salaspils, Latvia
[2]University of Latvia, Faculty of Biology, Jelgavas 1, Riga, Latvia
[3]WSL, Zurcherstrasse 111, Birmensdorf ZH, Switzerland
Correspondence: robism@inbox.lv

Keywords: quantitative wood anatomy, local population, canopy status, non-structural carbon reserves

Quantitative wood anatomy is emerging as a new and perspective discipline of dendro-sciences, extending beyond the width components of tree-rings thus aiming for deeper understanding of xylogenesis and ecophysiological responses of trees. At present, conductive and cell wall properties of tracheids and vessels have been among the most studied proxies; however, relatively little attention has been paid to storage tissues, e.g., wood rays. Considering weather-related fluctuation in assimilation, inter- and intra-annual variation in quantity of wood rays has been observed; yet due to weather related specifics in carbon allocation, the variation pattern can differ from that in wood increment.

The aim of this study was to assess variation in quantity of wood rays in xylem of middle-aged Scots pine of different social (canopy) status in a commercial stand. We assumed, that trees of different social status show diverse patterns in variation of wood rays due to specific carbon allocation patterns. Tangential thin sections of early- and latewood from increment cores were prepared by a hand sliding microtome. The number and size of wood rays was measured using WinCELL. The measured time series of wood ray proxies were rather short (< 50 years), as parenchyma in older wood rays had lignified and was not disguisable. Earlywood and latewood differed by size and quantity of wood rays; wood rays were more numerous in latewood. Quantity of wood rays displayed high-, and well as medium-frequency variation.

Acknowledgement

This study was funded by European Regional Development Fund.

PO34

Tree climate sensitivity in environmental and geographical space over Europe

Mikac, Stjepan[1]; Levanič, Tom[2]; Žmegač, Anja[1]; Trlin, Domagoj[1]; Orešković, Marko[1]; Lukač, Ljubica[1]

[1]University of Zagreb, Faculty of Forestry, Institute of Forest Ecology and Silviculture
[2]Slovenian Forestry Institute
Correspondence: smikac@gmail.com

Keywords: ecological niche space, Euclidian distance, geographical distance, climate sensitivity, environmental similarity

Trees have tolerance limits to environmental factors, outside which individuals cannot survive, grow or reproduce. Multidimensional space of environmental factors (also known as hyper-volume space) presents a well-known ecological niche concept. This concept became the basis for prediction, analysis and modeling of species distribution. In this research we are analyzing tree growth climate sensitivity of main European tree species in the context of multivariate ecological niche. The hypothesis in this research were: (1) ecological niche space explains much more variability in tree growth climate sensitivity than geographical space (2) tree growth climate sensitivity increases with distance from the ecological niche center (ecological optimum). Research was conducted on a total of 800 sites (Babst et al. 2012) compiling 50 new sites from southern Europe. Ecological niches were created using EU-Forest, a high–resolution tree occurrence dataset for Europe (Mauri et al. 2017) and gridded ClimateEU: historical and projected climate data for Europe (Hamann et al. 2013). The impact of climate variability on growth was analyzed using standard statistical analysis: linear correlation and moving correlation with the mean monthly and sesonal gridded temperatures and precipitation data taken from the CRU database for the last 100 years. Overall, our results highlight that niche concept explains much more variability in tree growth climate sensitivity than traditional geographical space which opens a new view in discussions about the future climate change impact of European tree species.

References

Babst, F., Poulter, B., Trouet, V., Tan, K., Neuwirth, B., Wilson, R., Varrer, M., Grabner, M., Tegel, V., Levanic, T., Panayotov, M., Urbinati, C., Bouriaud, O., Ciais, P., Frank, D., 2012. Site- and species-specific responses of forest growth to climate across the European continent. Global Ecology and Biogeography 22, 706–717.

Mauri, A., Strona, G., San-Miguel-Ayanz, J., 2017. EU-Forest, a high-resolution tree occurrence dataset for Europe. Scientific Data 4, Article number: 160123.

Hamann, A., Wang, T., Spittlehouse, D.L., Murdock, T.Q., 2013. A comprehensive, high-resolution database of historical and projected climate surfaces for western North America. Bulletin of the American Meteorological Society 94: 1307–1309.

PO35

Influence of climate change on the radial growth of European ash in the stands of the Western and Eastern Forest-steppe of Ukraine

Mykhalivna, Koval Iryna[1]; Borysova, Valentyna Leonidovna[2]

[1]Ukrainian Research Institute of Forestry and Forest Melioration, Laboratory of Forest Ecology, Pushkinska 86, 61024 Kharkiv, Ukraine
[2]Kharkov National Agrarian University named after V.V. Dokuchaev, Kharkiv, Ukraine, Department of Forestry named after. BF Ostapenko, building 2, P / N „Dokuchaevske-2", educational campus KhNAU, 62483 Kharkiv region, Ukraine
Correspondence: Koval_Iryna@ukr.net

Keywords: Fraxinus excelsior L., the ash radial growth, climate change, Forest-steppe zone

The purpose of this research is to study the response of the radial growth of *Fraxinus excelsior* L. to climate change in the humid conditions of the Western and Eastern Forest-steppe of Ukraine.

Climatic conditions are characterized by an increase in continentality to the east. Correlation analysis is performed to identify the strength of relationships between the tree ring indices and climatic factors for 1978–1995 and 1996–2013. For second period there is an increase of temperature in the early spring, winter and during the growing season; mitigating the winter and decreasing precipitation in growing season.

We revealed a significant positive influence of the July temperatures on the ash radial growth (r = 0.50, tfact = 2.31, tteor = 2.12, ά = 0.05) in Western Forest-Steppe for 1978–1995, for the next years 1995–2013 the dependence of the ash radial growth increases from precipitation of June (r = 50, tfact = 2.50; tteor = 2.12, ά = 0.05), March–August (r = 0.51, tfact. = 2.38, tteor = 2,12, ά = 0.05) and April–June (r = 0.60, tfact = 2.32, tteor = 2.12 , ά = 0.05).

In the ash stand of Eastern Forest–steppe, the ash radial growth in 1978–1995 limited by the temperature of May, (r = –0.65, tfact = 2.40, tteor = 2.12 , ά = 0.05). During next years (1996–2013) no significant correlations were detected.

Ashen stand generally had greater sensitivity of radial growth to climate change in the Western Forest-Steppe than trees of the same species in the Eastern Forest-steppe.

PO36

Radial growth resilience of Quercus spp. after drought in extra-Carpathian region of Romania

Nechita, Constantin[1]

[1]*National Research and Development Institute for Silviculture „Marin Dracea" (INCDS)*
Correspondence: nechitadendro@gmail.com

Keywords: drought stress, resilience indices, tree rings, earlywood, latewood

Severe drought-induce decline episodes in Quercus spp. is being reflected as more widespread in particular in the South Europe forests. Climate change forecasted indicate that extreme climate events such as drought or late frost, will increase in near future in both severity and intensity (IPCC, 2018). The adaptation strategies at individual tree-growth level in diverse ecosystems to extreme events remains a key issue in ecology. We investigate growth reduction episodes occurred in East and South Romanian Carpathians after 1900 until present analyzing occurrence of drought in different geoclimatic condition. The effect of severe extreme climate events was quantified for pedunculate oak (*Quercus robur* L), sessile oak (*Quercus petraea* (Matt.) Liebl.) and grayish oak (*Quercus pedunculiflora* K. Koch) at 18 sites located in steppe, forest-steppe, hills and river meadow. Resistance and resilience of tree growth were analyzed based on tree-rings (earlywood, latewood and ring width) of over 700 trees. Resistance, recovery and resilience indices were calculated. The assessment of relationship between tree ring response and environmental drivers was analyzed using Pearson correlation analysis and Partial Least-Squares regression (PLS). We found significant negative relationship among mean temperature, from spring of the current year and growth. A positive effect on trees growth under rainy springs were noticeable in low elevation stands. Standardized precipitation evapotranspiration index and maximum temperature indicating significant and negative correlation with growth of trees from steppe and forest-steppe ecosystems. Our study highlights that extreme events may have different effect on tree growth of oaks in the event year and subsequent years depending on geoclimatic condition.

References

IPCC, 2018. Intergovernmental Panel on Climate Change. Global Warming of 1.5 °C.

Acknowledgement

This work was supported by a grant from the Romanian National Authority for Scientific Research and Innovation, BIOSERV programme, PN19070501 grant.

PO37

Climatic and anthropogenic influences in the northern Romania peat bog interpreted from tree-ring widths

Nechita, Constantin[1]; Popa, Ionel; Badea[1], Ovidiu Nicolae[2]

[1]National Research and Development Institute for Silviculture „Marin Dracea" (INCDS), Calea Bucovinei, 73 bis, Câmpulung Moldovenesc, Romania
[2]National Research and Development Institute for Silviculture „Marin Dracea" (INCDS), Bucuresti, Romania
Correspondence: nechitadendro@gmail.com

Keywords: peat bog, Pinus sylvestris, Carpathians, pointer year, components of resilience

Dendrochronological research on radial growth of *Pinus sylvestris* in Cosna peat bog, northern Romania has been conducted. In the 1970s in this site drainage ditches to collect stagnant water were dug. The aim of the study was to estimate the effects of drainage to the radial growth and to assess differences on the impact of climatic factors for tree-rings formation. The impact of droughts on the radial growth of scot pine using pointer years and components of resilience was also investigated. Several transects in the bog, from a drainage ditch (point zero) to inward of the bog. Over 200 pine trees (diameter >10 cm) were cored through the trunk (2 radii). The transect points were located at increasing distances from each other from 0 m to 50 m and 100 m. Our results indicated strong impact of the drainage only at 0 m and 50 m. The reaction to the drainage occurred within 2–3 years and with increasing distance the influence from the ditch has become insignificant. Negative significant and stable correlation with maximum temperature has been observed in November previous growing season. Pines growing on wet boggy sites have been concluded to be sensitive to dry climate condition in summer.

Acknowledgement

This work was supported by a grant from the Romanian National Authority for Scientific Research and Innovation PN-III-P4_ID-PCE-2016-0253 and PN 502.

PO38

Climate sensitivity of Norway spruce (Picea abies (L.) H. Karst.) in the Dinaric Alps

Orešković, Marko[1]; Mikac, Stjepan[1]; Žmegač, Anja[1]; Trlin, Domagoj[1]

[1]University of Zagreb, Faculty of Forestry, Institute of Forest Ecology and Silviculture
Correspondence: smikac@gmail.com

Keywords: Dinarides, drought, climate change, dendrochronology, growth decline

Dinaric mountains represents the southernmost part of Norway spruce area in Europe. It represents the largest diversified morphologically complex of the karst landscape in Europe. The climate condition over Dinarides are very diverse over the small geographical area. Previous studies of the spruce sensitivity and climate variability in the Dinaric area were not conducted. Therefore, this study aims to analyze the impact of climatic factors (temperature and precipitation) on the variability of the radial growth of high elevation spruce stands in the area of its southern border geographical distribution. The impact of climate variability on growth was analyzed using standard statistical analysis: a bootstrap linear correlation, response function, partial seasonal correlation and moving correlation with the mean monthly gridded temperatures and precipitation data taken from the HISTALP database for the last 100 years. Results of the analysis suggest that high temperatures (especially in the summer of the previous and current year) have a limiting effect on the growth of spruce. In contrast precipitation (December to March) records show less significant but positive impact on growth. The negative impact of air temperature is stable over the last 100 years while precipitation show significant temporal instability, particularly those in December. Such variability of rainfall is primarily related to solid precipitation (snow level), which shows a significant decline over the last 50 years. Spruce is particularly vulnerable in the Dinarides and its future survival solely depends on the climate and karst relief where retiring at the northern expositions, cooler and wetter valleys, sinkholes and frost areas.

PO39

Tree ring dating and provenance of oaks from a 17th century slipway buried in the Tagus riverbank, Lisbon (Portugal)

Péres-de-Lis, Gonzalo[1]; Lauw, Alexandra[2]; Daly, Aoife[3]; García-González, Ignacio[4]; Pinto, Daniel[5]; Sarrazola, Alexandre[6]; Bettencourt, José[7]; Macedo, Marta Lacasta[6]; Pereira, Helena[2]; Nabais, Cristina[8]

[1]Université de Lorraine, AgroParisTech, INRA, Silva, F-54000, Nancy, France
[2]Centro de Estudos Florestais, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal
[3]Saxo Institute, University of Copenhagen, Karen Blixens vej 4, 2300 Copenhagen S, Denmark
[4]Universidade de Santiago de Compostela, Departamento de Botánica, Escola Politécnica Superior de Enxeñaría, Campus Terra, 27002 Lugo, Spain
[5]Centro de Estudos em Arqueologia, Artes e Ciências do Património (CEAACP), Universidade de Coimbra, Coimbra, Portugal
[6]ERA-Arqueologia, S.A., Calçada de Santa Catarina, 9C, 1495-705 Cruz Quebrada-Dafundo, Portugal
[7]CHAM – Centre for the Humanities, Departamento de História, Faculdade de Ciências Sociais e Humanas, Universidade Nova de Lisboa, Avenida de Berna, 26C, 1069-061 Lisboa, Portugal
[8]Centre for Functional Ecology, Department of Life Sciences, Faculty of Sciences and Technology, University of Coimbra, Coimbra, Portugal
Correspondence: crnabais@bot.uc.pt

Keywords: archaeology, cultural heritage, provenance, tree rings, wood identification

Archaeological works in the riverside area of Lisbon (Portugal) exposed the remains of several 16th to 19th centuries structures related to maritime activities. The slipway of Praça Dom Luís I (PDL) was discovered in 2012, buried at 6 m deep, at the northern bank line of the river Tagus. The archaeological excavation revealed a 300m2 timber structure perpendicular to the shoreline. The slipway, on a slope of half a meter oriented from North to South, was composed of three horizontal wooden layers: the bottom (layer C), over the river sediments, included about 70 pieces of reused ship timbers; the middle one (layer B), perpendicular to the river, was mainly composed of longitudinal conifers; the top one (layer A), creating a working floor, parallel to the river, was mainly made of oak. Up to 44.2% of the 224 discs collected at PDL were identified as conifers, while the remaining 55.8% were angiosperm ring-porous wood. A total of 44 tree-ring width series measured on 40 oak samples were successfully dated, obtaining a mean chronology with a span of 124 years, from 1547 to 1670. The PDL chronology significantly correlated with reference oak chronologies from the Netherlands, attaining a t-value of 6.60, while lower correlation scores were found for other series from northern Europe. These results show that oak PDL timbers were not from local or even regional origin. However, it was not possible to precise the actual provenance given that the above-mentioned reference chronologies probably corresponded to imported timbers as well.

PO40

Intra-annual shoots length growth of trees and dwarf shrubs in treeline of Eastern Carpathians

Popa, Ionel[1]; Semeniuc, Anca[1]; Balabasciuc, Mihai[1]

[1]National Institute for Research and Development in Forestry Marin Dracea, Calea Bucovinei 73bis, Campulung Moldovenesc, Romania
Correspondence: popaicas@gmail.com

Keywords: ecotone, shoot length, dendroclimatology

High altitude mountain ecosystems are ones of the most vulnerable and sensitive components of the Natural Capital to climate change effects and represents monitoring regions for the evaluation of ecosystem response and adaptation to global warming. In high mountain ecosystems, the trees and dwarf shrubs growth is assume to be limited by temperature, and most scientists expect a significant increase of growth due to recent and future warming. The main aim of this study is to fill the gaps on data and knowledge about the shoots length growth dynamics of trees and dwarf shrubs from high altitude ecotone of Carpathians region.

To highlight the shoots length growth dynamics at intra-annual level, three tree species and six dwarf shrubs species and two slope aspects (sunny and shade) in two high altitude location from Eastern Carpathians (Romania) where analysed and monitorized weekly in 2018 and 2019, during the growing season.

The results reveal a differentiation at species and slope aspects level in the dynamics of the growth processes in shoots length and phenophases. A 5-10-day delay was observed between the shaded slopes compared to the sunny ones on the dynamics of the shoot length growth phenology. Also a delay of 10 to 15 days in shoots growth start was observed between 2018 and 2019. The length of the shoot length growing season varies from species to species, ranging from 60 to 90 days. Generally, the maximum length is observed on the sunny slope 70–90 days, and the minimum on the shaded 60–70 days.

Acknowledgement

This work was supported by a grant of Ministery of Research and Innovation, CNCS – UEFISCDI, project number PN-III-P4-ID-PCE-2016-0253, within PNCDI III.

PO41

How do sea ice and climate interact to determine willow growth across Greenland?

Power, Candice Casandra[1,2]; Normand, Signe[1,2]

[1]Aarhus University, Center for Biodiversity Dynamics in a Changing World, Department of Bioscience, Ny Munkegade 116, 8000 Aarhus, Denmark
[2]Aarhus University, Section of Ecoinformatics and Biodiversity, Department of Bioscience, Ny Munkegade 116, 8000 Aarh
Correspondence: candicecpower@bios.au.dk

Keywords: Salix arctica, Salix glauca, sea ice interactions, Greenland shrub growth, structural equation modelling

The Arctic is warming at a higher rate than the global average and sea ice extent is declining rapidly. One response of this changing environment is Arctic greening, which is strongly associated with an increase in shrub growth and recruitment. Most studies of climate change impacts on Arctic vegetation have focused on changes in shrub cover and abundance, while considerably less effort has been invested in understanding the factors controlling variation in growth. Using methods of dendrochronology adapted for shrubs, our study provides an integrated analysis of local variation in growth across large scales. Specifically we assess through which climatic variables sea ice acts to determine the variation in growth of two Willow species (*Salix arctica* and *Salix glauca*) across Greenland. Using Structural Equation Modelling, we investigate and disentangle the relationships between potential predictors, including sea ice extent, thawing degree-days, and summer precipitation, and their effect on annual shrub growth. Methodology and preliminary results will be presented and discussed. With this study we aim to improve our understanding of the causes of variation in shrub growth across Greenland, which is essential for more accurately predicting potential impacts of future warming on Arctic ecosystems.

PO42

Dendrochronological analysis in support for historical sources: evidence of the battles for the medieval Vilnius Castles

Pukienė, Rūtilė[1]

[1]*National Museum Palace of Grand Dukes of Lithuania, Scientific Research Centre, Katedros sq. 4, LT 01143, Vilnius, Lithuania*
Correspondence: r.pukiene@valdovurumai.lt

Keywords: dendroarchaeology, military history, the Northern Crusades, medieval Lithuania, the Teutonic Order

The Castles of Vilnius have been an administrative centre of Lithuanian state since the early 14th c. at least. Intensive archaeological investigation into the site provided a bulk amount of timbers suitable for dendrochronological dating and therefore a medium to understand the site dynamics since the 1260's. The largest cluster of the dates falls to the second half of the 14th century.

The period marks a milestone in the history of Lithuanian state.

Transition between generations in the pagan ruling dynasty triggered succession wars aggravated by the increased military activity of the Teutonic Order. Moreover, in 1386 Grand Duke Jogaila (Jagiełło) ascended also a throne of Poland and officiated at the Conversion of Lithuania in 1387. The Vilnius Castles became a centre of the struggles for three decades and suffered a series of attacks: in 1377, 1383, 1390, 1394, and in 1402.

This perturbed time left rich cultural layer in the Lower Castle territory. Dendrochronological investigation of the wooden structures has revealed that many dates of tree felling (and hence building or rebuilding of the structures) correlate with the dates of the events mentioned in historical sources. Planked roads were re-paved in 1377, 1384, 1388, and 1403. Wooden houses, probably destined for military or storage needs or as shelters for citizens, were built and rebuilt in 1377, 1383–1384, 1390–1392, and 1394–1395. There are also still unidentified wooden structures which were built in this time. Thus the analysis of material clues amplified our knowledge on the history of this important period.

PO43

Prospects of dendropyrological research into raised bogs in Lithuania

Pukienė, Rūtilė[1]; Kibirkštis, Gintautas[2]; Taminskas, Julius[2]

[1]Nature Research Centre, Laboratory of Nuclear Geophysics and Radioecology, Akademijos Str. 2, LT-08412 Vilnius, Lithuania
[2]Nature Research Centre, Laboratory of Climate and Water Research, Akademijos Str. 2, LT-08412 Vilnius, Lithuania
Correspondence: r.pukiene@valdovurumai.lt

Keywords: Pinus sylvestris, fire scars, wildfire history, peat deposits, climate and ecosystem dynamics

Active raised bogs are important habitats for biodiversity conservation and as a sink in global carbon cycle. Bog fires have a huge effect on vegetation and peat deposition dynamics, but, differently from hydroclimatic parameters, scientific research on fire factor in bog ecosystem dynamics is scarce.

The poster will present an ingoing project aimed to study wildfire history, potential precursory factors and conceivable consequences at raised bog habitats. A semi-pristine Čepkeliai wetland complex (5858 ha, 54°01‘N, 24°32‘E) was chosen for this study in southern Lithuania.

First objective is to study tree rings and fire scars of Scots pine trees growing in raised bog habitats for reconstructing fire history and spatial patterns. Scarred pine trees and remnants of burned stems are scattered over the different parts of the bog complex. Dendrochronological analysis of cross section samples of the damaged trees is to be used to attain the objective. The initial analysis has already showed different fire chronologies at different sites.

Second objective is to study changes in bog water table, acrotelm depth and bog surface level, their interactions, dependence on climatic factors and fire events, impact on pine growth and fire danger conditions. In different parts of the bog complex 6 sampling plots with 57 measurement wells have been installed to collect the data.

A comparative dendrochronological analysis on fire-disturbed and undisturbed pine stands as well as demographical analysis and remote sensing will help to attain third objective, i.e. to study reaction of Scots pine population and vegetation cover to bog fires.

PO44

Diameter distributions related to age and disturbance history in Carpathians primary spruce forest in Europe

Rodrigo, Ruffy[1]; Janda, Pavel[1]; Mikoláš, Martin[1]; Pettit, Joey[1]; Svoboda, Miroslav[1]

Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Department of Forest Ecology, Kamýcká 129, 165 00 Praha 6 – Suchdol, Czech Republic
Correspondence: rodrigo@fld.czu.cz

Keywords: diameter distributions, unmanaged primary forest, disturbance history, Picea abies, Europe

Natural disturbances are key drivers of forest ecosystem dynamics. Historical disturbances strongly influence the structure and development of stand in unmanaged primary forests. Characterizing the structure of unmanaged forests can provide essential information for forest managers. One common way to look at the patterns and dynamics of forest structure is through diameter distributions. Diameter distributions have been widely used in assessing disturbance within forests. The focus of this current research is to look at the patterns of diameter distributions across the stands and countries in Carpathian mountains region in response to historical disturbance. Our objectives of this study were to (1) determine the range of variability between stands/plots with respect to diameter distributions, and (2) evaluate the impact of age and disturbance severity and timing on diameter distributions. The study was conducted in the primary forests of the Carpathian Mountains (Romania, Slovakia and Ukraine) which are dominated by Norway spruce (*Picea abies* L. (Karst.). A total of one hundred ninety circular plots (1000 m^2) were established using a stratified random sampling design. Diameter at breast height (dbh; measured at 1.37 m height) and species of all living trees ≥6 cm dbh was measured. For dendrochronological analysis, increment cores were collected and processed following standard dendrochronology methods. Disturbance history (severity and timing) was reconstructed by examining individual tree growth trends in order to describe and explain its influence on current diameter distributions. To provide quantitative basis for comparison, a weibull function was fit for each plot. The weibull distribution shape parameter can give us information on recruitment and mortality of certain dbh classes. In addition, to describe the impact of age and disturbance severity and timing, we used these variables in a regression analysis to model the shape parameter. The results of this research can help us better understand how structural characteristics and forest functioning responds to variation in past disturbances which can provide insights into future resilience to climate-driven alterations of disturbances.

PO45

Growth rings in successional species of a seasonal tropical dry forest in Mexico

Romero, Eunice[1]; Meave, Jorge[1]; Terrazas, Teresa[2]

[1]National Autonomous University of Mexico (UNAM), Faculty of Sciences, Dep. of Ecology and Natural Resources, Ciudad Universitaria, Coyoacán, Ciudad de México, 04510, Mexico
[2]National Autonomous University of Mexico (UNAM), Biology Institute, Ciudad Universitaria, Coyoacán, Ciudad de México, 04510, Mexico
Correspondence: i.eunice.romero.lipa@gmail.com

Keywords: growth marks, diffuse-porosity, earlywood, latewood, ring-porosity

Growth rings in temperate tree species are conspicuous, while in tropical species commonly they are not or have different patterns than temperate ones. Plant species growing in tropical dry forest are mostly deciduous associated to a well-marked dry season (up to seven months), thus we expect tree species to have conspicuous growth rings. Tropical dry forest is suffering high deforestation and species occurring in early successional recovering communities face higher temperatures, light intensity and water deficit than species in late successional communities. Through wood transverse sections, we characterized porosity type and growth rings of 13 common successional species growing in a tropical dry forest in the Tehuantepec Isthmus, Oaxaca, Mexico. Notably, eleven species had diffuse-porosity and only *Lysiloma divaricatum* and *Mimosa eurycarpa* showed ring porosity. Sixty three percent of the species with diffuse porous wood had growth marks whereas *Jacaratia mexicana*, *Pachycereus pecten-aboriginum* and *Pilosocereus collinsii*, restricted to late communities, did not showed growth marks. Growth marks were delimited mainly by smaller radial diameter in fibers (for example *Coccoloba liebmanii* and *Mimosa eurycarpa*) plus a higher vessel number in earlywood (*Bonellia macrocarpa*) or less vessel number in latewood (*Mimosa tenuiflora*). Although early successional community has a higher number of species with growth marks, there is a great intra-specific variation, as some individuals in late communities had marks but in the early communities did not as in *Phyllostylon rhamnoides*. Several individuals per species need to be sampled because growth marks visibility is highly variable suggesting high plasticity associated to environmental variables.

PO46

Effect of regeneration method on within-stem distribution of wood density of Scots pine

Schönfelder, Ondřej[1]; Zeidler, Aleš[1]; Borůvka, Vlastimil[1]

[1]Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences, Department of Wood Processing and Biomaterials, Kamýcká 129, 165 00 Prague, Czech Republic
Correspondence: zeidler@fld.czu.cz

Keywords: Pinus sylvestris, shelterwood regeneration, wood, density, X-ray

Scots pine (*Pinus sylvestris* L.) is the second most important commercial coniferous tree species after Norway spruce and its importance will be increasing with expected climatic changes. We tested the effect of two different silvicultural regeneration methods, the clear-cutting method and the shelterwood method, on a distribution of wood density, annual rings width and proportion of the latewood in a stem in the radial direction. The testing material came from a representative locality of the Czech Republic, which is characterized by the occurrence of pine forests. In this locality, stands representing two different methods of regeneration were selected and sample trees were cut. A disc was taken from each sample tree and subjected to densitometric examination by X-ray.

The shelterwood regeneration method has justification in the pine forests management in the Czech Republic, as it produces wood of different structure and qualitatively different properties than in the case of the clear-cutting method. In contrast to the currently prevailing clear-cutting regeneration method, wood of trees regenerated by shelterwood method has a more even distribution of annual rings width and a higher proportion of the latewood in the annual rings. For these reasons, the produced wood also shows higher density values, especially in the zone before targeted release of the maternal stand. Thus, it can be stated that the applied type of silvicultural treatment significantly affects the quality of pine wood, as the density, as a basic physical quantity, significantly affects most of the physical and mechanical wood properties.

Acknowledgement

The research was supported by the Ministry of Agriculture of the Czech Republic, project number QJ1520037 – „Increasing the adaptability of pine (*Pinus sylvestris* L.) silviculture in the conditions of the Czech Republic“ and by Internal Grant Agency of the Faculty of Forestry and Wood Sciences project number A_19_07.

PO47

Standards for estimating the birch stem volume in urban green space

Shevelina, Irina V.[1]**; Nuriev, Dmitriy N.**[1]**; Nagimov, Zufar Ya.**[1]

[1]*Department of Forest Dendrometry and Forest Inventory, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation*
Correspondence: lxf@usfeu.ru

Keywords: stem volume, urban green spaces, Betula pendula Roth, Middle Urals, Russia

The object of research is greenery of birch (*Betula pendula* Roth) on the territory of Yekaterinburg city (Middle Urals, Russia). Currently, there are no tables of trunk volumes for such urban tree plantings, because it is impossible to cut down trees for analysis in the city. Modern software-measuring complex (SMC) allows an engineer to determine the trunk volume (V) i. e. trunk diameters at different heights on growing trees. We used SMC «Field-Map» (IFER, Czech Republic) for measuring parameters on more than 100 growing trees in urban green spaces. In practice, for creating the tables of trunk volumes on the basis of small samples three indicators are usually estimated: diameter (D), height (H) and form factor (q2). The shape of the birch tree trunks in greening plantings varies widely. For example, form factor values are in the range from 0.352 to 0.730. That is why we used three categories of trees according to their shape. It was found the following equation for assessment of birch trunk volumes: V = 0.000025 · D^2 · H + 0.129576 · q2. This equation turned out to be the best in terms of the coefficient of determination (0.8) and Student‘s t-criteria.

The equation and tables developed on its basis take into account the specifics of the tree growth in urban green spaces and provide quite acceptable results: the systematic error was +3.11%, and the residual mean square error is ±10.66%.

PO48

Relationships between phenology and ecophysiology in two contrasting ring-porous tree species

Stojanović, Marko[1]; Noyer, Estelle[1]; Fajstavr, Marek[1]; Pericolo, Osvaldo[2]; Horáček, Petr[1]

[1]Global Change Research Institute, Academy of Sciences of the Czech Republic, Bělidla 4a, 603 00 Brno, Czech Republic
[2]School of Agricultural, Forestry, Food and Environmental Sciences, University of Basilicata, 85100 Potenza, Italy
Correspondence: stojanovic.m@czechglobe.cz

Keywords: pedunculate oak, narrow-leafed ash, drought, xylogenesis, leaf phenology

Recent changes in floodplain forests in central Europe, mainly caused by hydrological management and more frequently occurring droughts in the course of climate change, have resulted in serious deterioration of floodplain ecosystems. We hypothesized that observed drought caused by deficit in spring–summer precipitation is less compensated by available groundwater and therefore increases climate sensitivity of growth. Hence, the main objective of this study was to evaluate the sensitivity of trees to drought by observing environmental variables (climate), tree stem radial growth (xylogenesis), physiology (sap flow) and leaf phenology. The study was performed in floodplain forest, located 6.5 km to the north of the confluence of Morava and Dyje rivers in the Czech Republic, composed mainly of ring-porous *Quercus robur* (QR) and *Fraxinus angustifolia* (FA) species in dominant tree strata. Leaf phenology, sap flow and xylem growth of six QR and the same number of FA were monitored from March until November in 2017 and 2018, of which 2018 was warmer and drier. We focused here on coordination between leaf phenology, intra-annual sap flow pattern and early-wood vessel formation in two contrasting ring-porous species. The QR and FA significantly differed in their water consumption and early-wood vessel size, which is related to their physiology, first being anisohydric and former being isohydric tree species. In the context of future more frequent drought events, stomatal behaviour of these species might have a crucial role in their preservation on this location.

Acknowledgement

This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic within the National Sustainability Programme I (NPU I), grant number LO1415.

PO49

Outside–xylem tissues as the main origin of daily stem diameter variation in mature trees of Norway spruce

Světlík, Jan[1]; Krejza, Jan[1]; Bellan, Michal[1]

[1]Mendel University in Brno, Faculty of Forestry and Wood Technology, Dep. of Forest Ecology, Zemědělská 3, 613 00 Brno, Czech Republic
Correspondence: svetlikj@seznam.cz

Keywords: Picea abies, dendrometer, girdling, stem radius changes, water regime

Automatic dendrometer is precise tool to identify diurnal stem diameter changes. To understand what is seen in measured data it is crucial to identify whether main diurnal changes are realized in xylem, in outside-xylem tissues and what is specific share of volume changes of particular tissue. The identification where the stem diameter variation (SDV) occurs in mature Norway spruce trees is essential for determination of wood cell formation itself and tree water regime in spruce stands. We selected three trees for girdling and three control trees. Girdling was carried out before the growing season of wood cell when the bark and phloem were removed in 20 cm wide strip (1m above the stem base). Automatic band dendrometers DRL26A (EMS Brno) were used for measuring of SDV below, in and above debarked area. There was not an evidence of growth of new wood cell below the girdling line, but the shape and amplitude of SDV was proved as similar compared to control trees. Significant differences were proved between diameter fluctuation of debarked stem area and the SDV measurements in stem area containing phloem and bark tissue (above and below girdling). The daily amplitude of SDV in girdling reached only 15 % of the amplitude of control trees, that represents daily amplitude of radial changes about 4 μm. Results showed that the most of daily stem diameter variation is situated outside the wood tissue and that SDV measurements are suitable for separation of the effect of tree water regime and wood cell growth.

Acknowledgement

Research was supported with Czech Mountain Forests Climate-Smart Forestry- CZECLIMO LTC17007 and project Determining the stress of Norway spruce by infrared thermography TJ01000309.

PO50

Medieval gold mine in Złoty Stok (SW Poland): the oldest traces of mining and metallurgy in the light of the radiocarbon and dendrochronological dating.

Szychowska-Krąpiec, Elżbieta[1]

[1]*AGH – University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Al. Mickiewicza 30, 30-059 Kraków, Poland*
Correspondence: agh@geol.agh.edu.pl

Keywords: dendrochronology, absolute dating, coniferous species, gold mine, Złoty Stok

Studies on the remains of old mines and steel mills in Lower Silesia (SW Poland), conducted for years, allowed for identification of old medieval centers. The gold mine in Złoty Stok is one of the oldest not only in Poland, but in Europe as well. This was fully confirmed by the absolute dating of wood from mining casings and charcoal from metallurgical heaps in Schlakenthal in Złoty Jar. Historic fir wood from the casings was dated dendrochronologically for the years 1238–1288 AD. The radiocarbon dating of charcoal from the original ironworks in Złoty Jar also pointed to the 13th century. Absolute dating of coniferous species (*Pinus sylvestris*, *Picea abies*, *Abies alba*), as well as deciduous Quercus sp., allowed for construction of absolute, dendrochronological coniferous standards, hitherto lacking for this part of Poland. The absolute dating of wooden casings, tools and mining equipment was performed in numerous adits (among others Ochrowa, Lisia, Mistrzów, Nowa Książęca, Okrągła), the black ramp, and in the shafts. This allowed to present a history of the progressive mining work in excavations on geotourist routes, their reconstruction and development.

References

Kyncl, J., Kyncl, T., 1998. Standardchronologien der Nadelgehölze. Zeitgemäβiger Zustand in Böhmen und Mähren. Kolloquium „Probleme der mitteleuropäischen Dendrochronologie“, Mikulčice, manuscript, 1–4.

Firszt, S., 2006. Badania archeologiczne nad Dolnośląskim górnictwem kruszcowym w latach 1975–2000, Pr. Nauk. Inst. Górn. Politech. Wrocławskiej 117, 267–275.

Szychowska-Krąpiec, E., 2010. Long-Term chronologies of pine (Pinus sylvestris) and fir (Abies alba) Mill.) from the Małopolska Region and their palaeoclimatic reconstruction. Folia Quaternaria 79, 5–124.

PO51

Differences in radial growth response to climate between Norway spruce and Dwarf pine growing in the treeline ecotone

Šenfeldr, Martin[1]; Mikušková, Jana[1]

[1]Mendel University in Brno, Faculty of Forestry and Wood Technology, Dep. of Forest Botany, Dendrology and Geobiocoenology, Zemědělská 3, 613 00 Brno, Czech Republic
Correspondence: martin.senfeldr@mendelu.cz

Keywords: treeline ecotone, Pinus mugo, Picea abies, climate-growth relationships, tree-ring width

Understanding differences between trees and shrubs growing in the treeline ecotone is a key for understanding the functioning of the treeline. In this study we deal with the diameter growth response of Norway spruce trees (*Picea abies*) and Dwarf pine shrubs (*Pinus mugo*) growing in the treeline ecotone to climate variables. The study was conducted in the Hrubý Jeseník Mts (Czech Republic). We constructed one robust standard chronology for each studied species using standard dendrochronological procedures. Then, we calculated Pearson's correlations between indexed tree-rings widths and monthly climatic variables (average temperature, precipitation total, PDSI – Palmer drought severity index). We found the radial growth of Norway spruce is positively influenced mainly by temperature in the growing season (May to July) and in November in the year preceding the creation of the tree-ring. In the case of monthly precipitation, their positive correlation with radial growth of spruce was recorded only in March. The growth of Dwarf pine was positively influenced by the growing season temperature only in June and in October in the year preceding the growth of the tree-ring. Monthly precipitation was negatively affected radial growth of pine in October in the year preceding the growth of the tree ring. Both spruce and pine showed no significant correlation with PDSI. Our results correspond to the general view that the most important factor for the growth of trees at the treeline is temperature in the growing season, which is not so important for shrubs. The monthly precipitation sums are far less important for both studied species. The drought is not limiting for both trees and shrubs in the study area.

PO52

Spatio-temporal relationship between false rings and climate at Mayna in Republic of Khakassia, Russia

Tomusiak, Robert[1]; Kędziora, Wojciech[1]; Szyc, Katarzyna[1]; Touchan, Ramzi[2]; Meko, David[2]; Anarbekova, Altynai[3]; Babushkina, Elena[4]; Baverstock, Jean[5]; Chahine, Tony[6]; Khotyanovskaya, Julia[7]; Kostyakova, Tatiana[4]; Peresunko, Pavel[3]; Rezsöhazy, Jeanne[8]; Shishov, Vladimir[3]; Tychkov, Ivan[3]; Upadhyay, Keshav[9]

[1]Warsaw University of Life Sciences – SGGW, Poland
[2]University of Arizona, USA
[3]Siberian Federal University, Russia
[4]Khakasian Technical Institute, Russia
[5]University of KwaZulu-Natal, South Africa
[6]Jouzour Loubnan, Lebanon
[7]Perm Federal University, Russia
[8]Catholic University of Louvain, Belgium
[9]Forest Research Institute University Dehradun, India
Correspondence: robert_tomusiak@sggw.pl

Keywords: false rings, slopes, intra-annual bands of latewood, dendroclimatology

False rings provide a new source of proxy data for historical environment conditions. False ring is a phenomena caused by sequence of drought and moisture during growing season. Difficult growth conditions on slopes influence the dynamics of tree-ring formation. The objective of this research was to compare some characteristics of false rings (frequency, season of false ring formation) depending on tree location on slope.

Research was carried out at three sample plots located near the Mayna Dam, on the left bank of the Yenisei River, in the taiga mountain area (Republic of Khakassia, Russia). All plots were located on a slope (25–50 degree). The cores were collected from Scots pines located between 350 and 420 m a.s.l. Mean age of trees was near 65 years. On each tree two cores were collected parallely to contour line. All wood samples were cross-dated and measured. False rings were identified by anatomical features within the wood. The relationship between climate (temperature and precipitation) and season of false ring formation (early earlywood, medium earlywood, late earlywood, latewood) was investigated.

As slope and altitude affects the availability of soil moisture, it was observed that altitude and slope impact on frequency of false ring formation and may determine their location within the growth ring.

PO53

Cowberry cover and age structure in Cladinoso-calunosa forest type (Latvia)

Treimane, Agita[1]; Berzina, Beate[1]; Elferts, Didzis[1]; Donis, Janis[1]

[1]LSFRI Silava, Rigas 111, Salaspils, Latvia; University of Latvia, Faculty of Biology, Jelgavas 1, Riga, Latvia
Correspondence: agita.treimane@lu.lv

Keywords: Vaccinium vitis-idaea, dwaft shrubs, age structure, canopy openness

Dwarf shrubs and berries are an important part of the biological diversity and one of the most important non-wood forest products. Cowberry is one of the most abundant ground vegetation species in nutrient poor pine forest ecosystems. Cowberry is evergreen, high plasticity dwarf shrub with ability to adapt to habitat changes, such as clear cutting, thinning selection cutting or selective cutting.

The aim of this research was to determine effect of density and canopy openness on cowberry age, frequency of occurrence and cover in three different stand aged (coppice, middle age and old stand) stands of Cladinoso-calunosa forest type.

Two sites in Latvia (24 forest stands with six plots per stand) were established in Latvia. In these 144 plots stands were described, data on vegetation collected and the dwarf shrub samples were collected for age structure determination in laboratory.

Significant differences of cowberry cover and age were observed between both sites. Analysis showed that canopy openness had negative relationship with cowberry age. Dwarf shrub age and height were positively correlated. Cowberry cover showed significant positive correlation with density only on middle age stands.

PO54

Climate response of Douglas fir reveals recently increased sensitivity to drought stress in Central Europe

Vejpustková, Monika[1]; Čihák, Tomáš[1]

[1]Forestry and Game Management Research Institute, Dep. of Forest Ecology, Strnady 136, 252 02 Jíloviště, Czech Republic
Correspondence: vejpustkova@vulhm.cz

Keywords: tree rings, dendroclimatology, growth trends, Pseudotsuga menziesii, Picea abies

Until now, Douglas fir has been considered a tree species resistant to drought. However, how Douglas fir will be able to cope with the increasing frequency and intensity of summer heat waves remains a question. The long-term variability in the climate response of Douglas fir in Central European conditions has not been fully explored. The aim of the study was to identify climatic factors controlling the stem radial growth of Douglas fir and Norway spruce, and to examine the temporal changes in tree responses to key climatic variables related to drought stress. We analysed the pattern of the climate–growth relationship of Douglas fir and Norway spruce, growing in mixed stands distributed between 260 and 600 m above sea level, which corresponds with the altitudinal zone of intensive spruce dieback in the Czech Republic. Nine-site tree-ring-width chronologies were developed for each tree species. Pointer year analysis and correlation analysis in combination with principal component analysis were used to identify climatic factors limiting their growth. Moving correlation function was computed to assess temporal changes of the climate–growth relationship. In the entire 1961–2015 period, growth of both species was positively related to summer precipitation. The response to temperature differed between species. While spruce was negatively affected by the temperatures in summer months, the increments of Douglas fir were positively correlated with the temperatures in February and March. However, moving correlation analysis revealed recently increasing sensitivity to summer temperatures also for Douglas fir. Higher responsiveness of Douglas fir to drought was also revealed by the increasing frequency of negative pointer years in the 2003–2015 period.

Acknowledgement

This research was funded by the National Agency for Agricultural Research, grant number QJ1520299 and by the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0118.

PO55

Medieval oak chronology from Klaipėda, Lithuania

Vitas, Adomas[1]

[1]*Centre of Environmental Research, Faculty of Natural Sciences, Vytautas Magnus University, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania*
Correspondence: ad8advi@gmail.com

Keywords: Quercus, medieval tree-ring width chronology, Klaipėda

Oak cross-sections were collected during archaeological investigations of Klaipėda old town and castle in 1978–1987. Oak chronology for Klaipėda includes 62 timber cross-sections and spans for 306 years from 1247 to 1552. Reliable chronology, when EPS is above 0.85, spans for 277 years from 1260 to 1536. High inter-correlation between oak tree-ring width series (0.49) indicates that timber was felled in ecologically homogeneous sites. Sampled oaks were slow growing with annual tree-ring of 0.96 mm. Moderately mean sensitivity (0.21) and standard deviation (0.46) indicates the high variation between adjacent tree rings as well as low-frequency variations (cycles with a wavelength greater than eight years). Spectral analysis of tree-ring series has indicated longer, on average 82 years, cyclical components. Recurrent periods of growth depressions took place in 1304–1310, 1355–1359, 1419–1425, 1431–1438, 1461–1464, 1469–1474 and 1491–1498. During a period of depressions, bands of extremely narrow rings are formed. Constructed oak chronology for Klaipėda shows high similarity with Baltic-1 and Gdansk (Pomerania) chronologies (r = 0.78 and 0.68), whereas the similarity with Vilquro and Smarhoń chronologies are not observed (r = –0.05 and –0.06). Comparison with other oak chronologies from the Baltic region indicates that the similarity between chronologies is determined not by geographical distance but is rather driven by the condition of growing. Narrow rings, growth depressions and longer cyclical components evidence that oaks used in timber constructions for Klaipėda grew in highly variable growing conditions and allowed us to draw a hypothesis that the oaks are sampled in waterlogged sites and that a recurrent surplus of groundwater limited their growth.

Acknowledgement

The author expresses sincere thanks to R. Pukienė, I. Tyers, T. Wazny and M. Zunde who allowed to use their oak chronologies.

PO56

Spatial and temporal variability of wood species selection for timber in Austria

Wächter, Elisabeth[1]; Nemestothy, Sebastian[1]; Mayer, Konrad[1]; Karanitsch-Ackerl, Sandra[1]; Grabner, Michael[1]

[1]University of Natural Resources and Life Sciences, BOKU, Vienna, Austria. Institute of Wood Technology and Renewable Materials, Konrad Lorenz Strasse 24, 3430 Tulln, Austria
Correspondence: elisabeth.waechter@boku.ac.at

Keywords: dendrochronology, wood species, timber, building history, wood species selection

Timber plays an important role in buildings – even if they are made of stones or bricks the material for roof trusses and ceilings is mainly wood. The exact determination of the age of historical timber is undoubtedly the most important contribution of dendrochronology to building research.
Prior to the dendrochronological analyses the wood species must be determined, which is done based on wood anatomical details.
10.561 samples from 954 historic buildings were dated to the period between the 13th and the 19th century at the BOKU dendro-lab which has its study area focused on the eastern part of Austria. Norway spruce (*Picea abies*) is the dominating construction wood in Austria identified at 60% of all timber samples, followed by silver fir (*Abies alba*), with 24%, pine (*Pinus sylvestris* and *nigra*) with 6%, oak (*Quercus petraea*, *robur* and *cerris*) with 4% and larch (*Larix decidua*) with 5% and a small number of other species.
The ratio of Norway spruce increased from 23% in the 13th century to 64% in the 19th century. Pine showed some variation over time, with its maximum of 9% during the 17th century. Oak and fir showed decreasing trends – oak from 11% (13th c.) to less than 1% in the 19th century and fir from 58% (14th c.) to 28% (19th c.). Thus, the ratio of fir to spruce has almost reversed over the centuries from 3:1 to 1:3.
Pine and oak are limited to the eastern and north-eastern part of Austria – according to their main distribution range. Fir was mainly found in the northern foothills of the Alps and Vienna (were the timber was floated to). Larch can be found in the alpine region as well as south of the main rim of the Alps.
However, the analysis of temporal and spatial variation of wood species selection for timber in Austria may be subject to sampling bias, with a varying selection of building types as well as building components over the temporal and spatial extent. This is caused by differences in availability of buildings, biased selection of components due to supposed dating success, as well as changing presence of a waney edge with changing production conditions. Furthermore different species show differences in dating success, therefore show non-equal probabilities to be included in the analysis. In addition to that, one has to consider „survivorship bias“ as the different wood species show differences in durability and therefore erroneous temporal trends may appear, even if species selection stays constant.

PO57

Dendrochronological analysis of the common ash in Poland.

Wojtan, Rafał[1]; Tomusiak, Robert[1]

[1]Warsaw University of Life Sciences – SGGW, Faculty of Forestry, Nowoursynowska 159, 02-776 Warsaw, Poland
Correspondence: rwojtan@wl.sggw.pl

Keywords: dendroecology, Fraxinus excelsior, tree-ring width, temperature, precipitation

The study was aimed to investigate the radial increment response of common ash (*Fraxinus excelsior* L.) to climatic conditions. 980 sample trees from 17 sites were used in this study. This material was used to develop local chronologies. The shortest one consisted of 67 and the longest of 149 tree rings.
Cluster analysis allowed to distinguish five dendrochronological regions of common ash in Poland. On the basis of these results, regional chronologies were created, which were used for dendrochronological analysis. In the investigation of growth response to climatic conditions the correlation and response function analysis were carried out.
For all regions, a significant, negative correlation with mean monthly temperature was found for April and June. The positive correlation between precipitation and radial growth at spring and beginning of summer (April–June) was observed.

PO58

Analysis of the forest fires frequency using fire scars in the conditions of the forest-steppe zone in the Urals

Zalesov, Sergei V.[1]; Fomin, Valery V.[2]; Dancheva, Anastasia V.[3]; Platonov, Evgeniy Y.[3]

[1]Department of Forestry, Ural State Forest Engineering University, Yekaterinburg, the Russian Federation
[2]Laboratory of Dendrochronology, Institute of Plant and Animal Ecology, the Russian Federation
[3]Laboratory of forest management, Kazakh Research Institute of Forestry and Agroforestry, Shchuchinsk, the Republic of Kazakhstan
Correspondence: fomval@gmail.com

Keywords: ground forest fire, fire scars, fires frequency, forest-steppe zone of the Urals, Pinus sylvestris L.

It is well-known that due to the thermal effect of the ground forest fire, the cambial stem cells at the soil surface die and as a result, we can see fire scars. At the same time, the tree retains its vitality because the fire scar does not cover it around. Due to the tree growth in the following years, the scar is overgrown. However, new fire scars are formed after repeated forest fire. The dendrochronological method allows to define the years when fire scars were formed and to calculate the forest fire frequency and fire turnover in the particular area. In addition, the number of model trees (stumps) with scars for one year determines the intensity of ground forest fire and consequently the fire situation in a particular year. The dating of forest fires was implemented using the stumps of pine trees (*Pinus sylvestris* L) in the conditions of the forest-steppe zone of the Urals (Cheliyabinsk region, Russia). Our studies have shown that the pine trees of 120–130-year-old have up to 5 forest scars in Pinetum vacciniosum forest type. If we consider that the undergrowth and young pine trees at the age of up to 20 years usually die during ground forest fires, this means that the forest fire frequency is 20 years. The use of this method is very important for the regions where systematic observations of forest fire frequency were not carried out.

PO59

Dating of the Russian heritage – St. Michael the Archangel Church (Transbaikalia)

Zharnikov, Zakhar Yurievich[1]; Sidorova, Maya Olegovna[2]; Vakhnina, Irina Leonidovna[3]; Myglan, Vladimir Stanislavovich[1]

[1]Siberian Federal University, Humanitarian Institute, Krasnoyarsk, Svobodniy , 79, Russia
[2]Institute of archaeology and ethnography SB RAS, Geochronology of cenozoic, Lavrentieva, 17, Novosibirsk, Russia
[3]Institute of Natural Resources, Ecology and Cryology SB RAS, Nedorezova, 16a, Chita, Russia
Correspondence: mayasidorova12@gmail.com

Keywords: wood architecture, Siberia, dendrodating, church

Today in the East Siberia the significance wooden architectural buildings XVI–XIX centuries are still alive. One of the unique construction is located in the centre of Chita city (Transbaikalia). It is called the Michael the Archangel Church. Nowadays this building is a museum of Decembrists (members of the Decembrist revolt (1825) who were exiled in Siberia). According to historical data, the church was built in 1776 of *Larix sibirica* Ledeb. Here we made dendrochronological analysis to check this information.

During 2017 we sampled cores from the church. The main problem was the lack of long tree-ring chronologies in Transbaikalia. To solve it we collected samples from living trees of three sites (*Larix sibirica* Ledeb. and *Pinus sylvestris* L.) and 10 wooden buildings XIX–XX centuries adjust the church. First, we built 365-year chronology by larch and 251-year by pinus. Second, we continued pine chronology to the 1670 year by dating buildings. Third, we analyzed church chronology with pine and larch chronologies. We dated church samples 1773–1774 and determined that all of them are *Pinus sylvestris* L.

Finally, we proved historical data and contradicted data about building material. More than that we created 571-year tree-ring chronology in Transbaikalia which can be used for dating and climatic analysis.

Acknowledgement

This work was supported by the Russian Science Foundation (No. 19-14-00028).

PO60

The first historical oak tree-ring chronologies for Latvia

Zunde, Māris[1]

[1]*University of Latvia, Institute of Latvian History, Dendrochronological Laboratory, Kalpaka bulvaris 4, LV-1050, Riga, Latvia*
Correspondence: zunde@lanet.lv

Keywords: Baltic, Latvia, Quercus robur, dendroprovenancing

It has been confirmed repeatedly by dendrochronology that at least from the 15th up to the mid 17th century the wooden panels for paintings in the northern part of Western Europe were generally made from so-called Baltic oak, which was extensively used at this time in Western Europe also for ships, barrels, sculptures, etc.

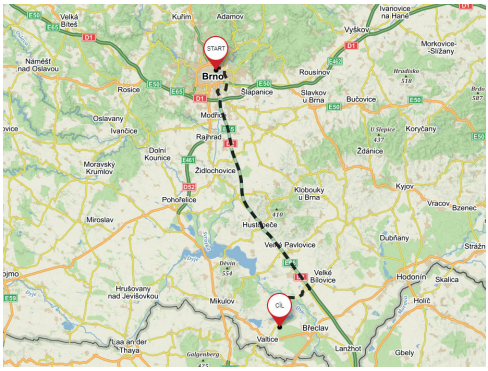
The significant differences separating many of the Baltic oak tree-ring chronologies indicate that the used trees grew often in widely separated areas. In fact, the timber was supplied to Western Europe not only from present-day Poland, the Baltic States and southern Scandinavia, but also from western Russia, Belarus and Ukraine. Accordingly, when discussing so-called Baltic oak or Baltic timber as such, the following questions arise: a) What geographical area does Baltic timber relate to, and how large is this area?; b) How can we determine more precisely the region providing timber exported to Western Europe in earlier times?

Answers to these questions come from dendrochronology, or more precisely, from the technique of dendropovenancing. This requires a sufficient number of absolute tree-ring chronologies for the source area of the particular species, covering the respective period. However, historical oak timber is nowadays rare in present-day Latvia, as in the other Baltic States. Considering the important scientific information contained in the tree-rings, attention has focussed in Latvia during the past couple of years on the recovery of historical oak wood and the study of the tree-rings. Now the first historical absolute tree-ring chronologies for oak have been compiled, spanning the overall period from the mid 11th to the mid 17th century.

Excursion

The excursion to the Lednice-Valtice Cultural Landscape

The participants will have the opportunity to visit a World Heritage Site protected by UNESCO. The excursion will be on Wednesday afternoon and include a visit to the Liechtenstein chateau and a nearby wine cellar.



Transport to the excursion is 60 km long and takes less than one hour

The Lednice-Valtice Cultural Landscape, also known as the Lednice-Valtice Area or Lednice-Valtice Complex (in Czech: Lednicko-valtický areál) is a cultural-natural landscape complex of 283.09 Km^2 in the Lednice and Valtice areas of the South Moravian Region, in the Czech Republic.

The Lednice-Valtice Cultural Landscape

The Lednice-Valtice Area is registered in the list of monuments protected as World Heritage Sites by UNESCO. It is adjacent to the Pálava Landscape Protected Area (Pálava Biosphere Reserve), World Heritage Site also registered by UNESCO. The close proximity of two cultural landscapes protected by UNESCO is unique.

History

The House of Liechtenstein, the family which reigns by constitutional, hereditary right over the nation of Liechtensten, acquired a castle in Lednice in 1249. This marked the beginning of their settlement in the area. It remained the principal Liechtenstein residence for 700 years, until 1939 and World War II.

The Dukes of Liechtenstein transformed their properties into one large private park between the 17th and 20th centuries. During the 19th century, the Dukes continued transforming the area as a large traditional English landscape park. The Baroque and Gothic Revival style architecture of their chateaux are married with smaller buildings and a landscape that was fashioned according to the English principles of landscape architecture.

The Lednice Ponds (Lednické rybníky) are situated between the villages of Valtice, Lednice, and Hlohovec; as are the Mlýnský, Prostřední, Hlohovecký, and Nesyt Ponds. A substantial part of the cultural landscape complex is covered in pine forests, known as the “Pine-wood” (Boří les), and in areas adjacent to the River Dyje with riparian forests.

Dinner will be held in a wine cellar in Velké Bílovice

The optional excursion to the Villa Tugendhat

The participants will have the opportunity to visit the Villa Tugendhat. The excursion will be on Friday after the ending of the conference. The excursion is not included in the registration fee.
The Villa Tugendhat is located very close to the conference venue (300 m).

The Villa of Greta and Fritz Tugendhat, designed by the architect Ludwig Mies van der Rohe and built in 1929–1930, is a monument of modern architecture, and is the only example of modern architecture in the Czech Republic inscribed in the list of UNESCO World Cultural Heritage sites.

Link to the official web page: http://www.tugendhat.eu/en/homepage.html

List of participant

Name	E-mail	Organisation/Company	Country
Akkemik, Ünal	uakkemik @istanbul.edu.tr	Istanbul University – Cerrahpasa	Turkey
Barrett, Marie-Therese	mbarrett08 @qub.ac.uk	Queens University Belfast	Northern Ireland
Baz, Sher	sherbaz91 @gmail.com	Federal Urdu University of Arts, Science and Technology	Pakistan
Begović, Krešimir	begovic @fld.czu.cz	Czech University of Life Sciences Prague	Czech Republic
Bernabei, Mauro	bernabei @ivalsa.cnr.it	Italian National Research Council (CNR)	Italia
Bijak, Szymon	szymon.bijak @wl.sggw.pl	Warsaw University of Life Sciences – SGGW	Poland
Bleicher, Niels	niels.bleicher @web.de	Underwater- and Dendroarchaeology Zurich	Switzerland
Brundin, Anders	andersomaarit @gmail.com	Senior Scientist	Sweden
Campelo, Filipe	fcampelo @ci.uc.pt	University of Coimbra	Portugal
Campioli, Matteo	matteo.campioli @uantwerpen.be	University of Antwerp	Belgium
Chizhikova, Nelli	nelly.chizhikova @kpfu.ru	Kazan Federal University	Russia
Chojnacka-Ożga, Longina	longina_chojnacka_ozga @sggw.pl	Warsaw University of Life Sciences – SGGW	Poland
Christie, Duncan	duncanchristieb @gmail.com	Universidad Austral de Chile	Chile
Christopoulou, Anastasia	anchristo @umk.pl	Nicolaus Copernicus University	Poland
Čada, Vojta	cada @fld.czu.cz	Czech University of Life Sciences Prague	Czech Republic
Čufar, Katarina	katarina.cufar @bf.uni-lj.si	University of Ljubljana	Slovenia
Dimitrov, Dimitar, Petrov	dimitrov_117 @abv.bg	Forest Research Institute, Bulgarian Academy of Sciences	Bulgaria
Dobrovolný, Petr	dobro @sci.muni.cz	Masaryk University/Global Change Research Institute, CAS	Czech Republic
Dox, Inge	inge.dox @uantwerpen.be	University of Antwerp	Belgium
Drobyshev, Igor	igor.drobyshev @slu.se	Swedish University of Agricultural Sciences (SLU)	Sweden
Elferts, Didzis	didzis.elferts @lu.lv	University of Latvia	Latvia
Fajstavr, Marek	fajstavr.m @czechglobe.cz	Global Change Research Institute, CAS	Czech Republic

Name	E-mail	Organisation/Company	Country
Fatiha, Abdoun	fatabdoun @yahoo.fr	University of Science and Technology Houari Boumediene	Algeria
Férriz, Macarena	ferriz.macarena @inia.es	INIA	Spain
Fomin, Valery	fomval @gmail.com	Ural State Forest Engineering University	Russian Federation
García-González, Ignacio	ignacio.garcia @usc.es	Universidade de Santiago de Compostela	Spain
Gennaretti, Fabio	fabio.gennaretti @libero.it	INRA Centre Grand Est, Nancy	France
Giagli, Kyriaki	giagli @mendelu.cz	Mendel University in Brno	Czech Republic
Gmińska-Nowak, Barbara	barbara.gminska @gmail.com	Nicolaus Copernicus University	Poland
Goisser, Michael	goisser @ecomatik.de	Ecomatik eK.	Germany
Grabner, Michael	michael.grabner @boku.ac.at	University of Natural Resources and Life Sciences, BOKU, Vienna	Austria
Gryc, Vladimír	gryc @mendelu.cz	Mendel University in Brno	Czech Republic
Grynaeus, András	dendro @ludens.elte.hu	Hungarian Dendrochronological Laboratory, Cincér Bt	Hungary
Häusser, Martin	martin.haeusser @fau.de	Friedrich–Alexander University Erlangen–Nürnberg	Germany
Henley, Benjamin, James	bhenley @unimelb.edu.au	University of Melbourne	Australia
Hereş, Ana-Maria	ana_heres @yahoo.com	Transilvania University of Braşov	Romania
Herzig, Franz	Franz.Herzig @blfd.bayern.de	Bavarian State Office for Monument Protection	Germany
Heussner, Karl-Uwe	karl-uwe.heussner @dainst.de	German Archaeological Institut	Germany
Huang, Weiwei	wh@ign.ku.dk	University of Copenhagen	Denmark
Ifticene-Habani, Naima	naimaifticene @hotmail.com	University of Algiers	Algeria
Izworska, Katarzyna	katarzynaizworska @gmail.com	Pedagogical University of Cracow	Poland
Janus, Alexander	alexander.janus @dainst.de	German Archaeological Institut	Germany
Jiang, Yuan	jiangy @bnu.edu.cn	Beijing Normal University	China
Kalela Brundin, Maarit	maaritkalelabrundin @gmail.com	Senior scientist	Sweden
Kang, Muyi	kangmy @bnu.edu.cn	Beijing Normal University	China

Name	E-mail	Organisation/Company	Country
Kašpar, Jakub	jakub.kaspar @vukoz.cz	The Silva Tarouca Research Institute	Czech Republic
Keck, John, R.	jrkeck @email.arizona.edu	University of Arizona	USA
Kemp, Marthie	kempm @ufs.ac.za	University of the Free State	South Africa
Kern, Zoltan	zoltan.kern @gmail.com	Research Centre for Astronomy and Earth Sciences, MTA	Hungary
Khan, Afsheen	khanafsheen913 @ymail.com	Federal Urdu University of Arts, Science and Technology	Pakistan
Kolář, Tomáš	koldatom @gmail.com	Mendel University in Brno/Global Change Research Institute, CAS	Czech Republic
Koňasová, Eva	eva.konasova @gmail.com	Mendel University in Brno	Czech Republic
Köse, Nesibe	nesibe @istanbul.edu.tr	Istanbul University – Cerrahpasa	Turkey
Koval, Iryna, Mykhalivna	Koval_Iryna @ukr.net	Ukrainian Research Institute of Forestry and Forest Melioration	Ukraine
Krąpiec, Marek	mkrapiec @agh.edu.pl	AGH University of Science and Technology	Poland
Krejza, Jan	krejza.j @czechglobe.cz	Global Change Research Institute, CAS	Czech Republic
Kshetrimayum, Ghanashyam, Singh	mani2paisa @gmail.com	Waikhom Mani Girls College	India
Kusbach Antonín	antonin.kusbach @mendelu.cz	Mendel University in Brno	Czech Republic
Kyncl, Josef	josef.kyncl.dendro @gmail.com	DendroLab Brno	Czech Republic
Läänelaid, Alar	alar.laanelaid @ut.ee	University of Tartu	Estonia
Lehnebach, Romaín	Romain.Lehnebach @UGent.be	Gent University	Belgium
Lukac, Ljubica	lukac.ljubica @gmail.com	University of Zagreb	Croatia
Lyu, Lixin	lixinlv @ibcas.ac.cn	Institute of Botany, Chinese Academy of Sciences	China
Malik, Rayees, Ahmad	rayeesmalik @iisc.ac.in	Indian Institute of Science (IISc)	India
Martiník, Antonín	antonin.martinik @mendelu.cz	Mendel University in Brno	Czech Republic
Matisons, Roberts	robism @inbox.lv	LSFRI Silava	Latvia
Matulewski, Paweł	matul @amu.edu.pl	Adam Mickiewicz University in Poznan	Poland
Mayer, Konrad	konrad.mayer @boku.ac.at	University of Natural Resources and Life Sciences, BOKU, Vienna	Austria

Name	E-mail	Organisation/Company	Country
Mikhailovich, Anna	anna.mikhailovich @gmail.com	Ural Federal University	Russian Federation
Mohajan, Babla	babla.ifescu @gmail.com	University of Padua	Bangladesh
Muigg, Bernhard	bernhard.muigg @wfg.uni-freiburg.de	University of Freiburg	Germany
Myskow, Elzbieta	elzbieta.myskow @uwr.edu.pl	University of Wrocław	Poland
Nabais, Cristina	crnabais @bot.uc.pt	University of Coimbra	Portugal
Nakkongkum, Pattarayuth	japan.galaxy45 @gmail.com	University of Phayao	Thailand
Nechita, Constantin	nechitadendro @gmail.com	National Research and Development Institute in Forestry "Marin Dracea"	Romania
Nemestothy, Sebastian	sebastian.nemestothy @boku.ac.at	University of Natural Resources and Life Sciences, BOKU Vienna	Austria
Nongthombam, Dhirendra, Singh	singnd @gmail.com	Waikhom Mani Girls College	India
Novak, Klemen	klemen.novak @bf.uni-lj.si	Universityi of Ljubljana	Slovenia
Oberhänsli, Monika	monika.oberhaensli @adg.gr.ch	Archaeological Service of the Canton of Grisons	Switzerland
Orešković, Marko	moreskovic10 @gmail.com	University of Zagreb	Croatia
Ożga, Wojciech	wojciech_ozga @sggw.pl	Warsaw University of Life Sciences – SGGW	Poland
Pereira, Gabriel	gabriel.g.s.pereira @gmail.com	Centro de Estudos de Arqueologia, Artes e Ciências do Património (CEAACP)	Portugal
Pérez-de-Lis, Gonzalo	gonzalo.perezdelis @gmail.com	INRA Centre Grand Est, Nancy	France
Phulara, Mohit	phularamohit14 @gmail.com	G.B. Pant National Institute of Himalayan Environment and Sustainable Development	India
Pinto, Daniel	danielagrpinto @gmail.com	Centro de Estudos de Arqueologia, Artes e Ciências do Património (CEAACP)	Portugal
Popa, Ionel	popaicas @gmail.com	National Research and Development Institute in Forestry "Marin Dracea"	Romania
Power, Candice, Casandra	candicecpower @bios.au.dk	Aarhus University	Denmark
Pukienė, Rūtilė	r.pukiene @valdovurumai.lt	National Museum Palace of Grand Dukes of Lithuania	Lithuania
Romero, Eunice	eunice.romero.lipa @gmail.com	National Autonomous University of Mexico	Mexico

Name	E-mail	Organisation/Company	Country
Rybníček, Michal	michalryb @post.cz	Mendel University in Brno/Global Change Research Institute, CAS	Czech Republic
Stojanović, Marko	stojanovic.m @czechglobe.cz	Global Change Research Institute, CAS	Czech Republic
Světlík, Jan	svetlikj @seznam.cz	Mendel University in Bnro	Czech Republic
Szychowska-Krąpiec, Elisabeth	szycha @geol.agh.edu.pl	AGH University of Science and Technology	Poland
Šamonil, Pavel	pavel.samonil @vukoz.cz	The Silva Tarouca Research Institute	Czech Republic
Šenfeldr, Martin	martin.senfeldr @mendelu.cz	Mendel University in Brno	Czech Republic
Tegel, Willy	tegel @dendro.de	Amt für Archäologie, Thurgau	Switzerland
Thounaojam, Rojen, Singh	rjemeitei @gmail.com	Manipur University	India
Tomusiak, Robert	robert_tomusiak @sggw.pl	Warsaw University of Life Sciences – SGGW	Poland
Treimane, Agita	agita.treimane @lu.lv	LSFRI Silava	Latvia
Treml, Václav	treml @natur.cuni.cz	Charles University	Czech Republic
Treydte, Kerstin	treydte @wsl.ch	Swiss Federal Research Institute WSL	Switzerland
Trlin, Domagoj	dtrlin @sumfak.hr	University of Zagreb	Croatia
Trouillier, Mario	mario.trouillier @uni-greifswald.de	University Greifswald	Germany
Tumajer, Jan	tumajer1 @email.cz	Charles University	Czech Republic
van Daalen, Sjoerd	vandaalen @dendro.nl	Van Daalen Dendrochronologie	Netherlands
Van den Bulcke, Jan	Jan.VandenBulcke @UGent.be	Gent University	Belgium
Vavrčík, Hanuš	vavrcik @mendelu.cz	Mendel University in Brno	Czech Republic
Vejpustková, Monika	vejpustkova @vulhm.cz	Forestry and Game Management Research Institute	Czech Republic
Vieira, Joana	joana.vieira @uc.pt	University of Coimbra	Portugal
Vitas, Adomas	ad8advi @gmail.com	Vytautas Magnus University	Lithuania
Wächter, Elisabeth	elisabeth.waechter @boku.ac.at	University of Natural Resources and Life Sciences, BOKU, Vienna	Austria
Walder, Felix	felix.walder @zuerich.ch	Underwater- and Dendroarchaeology Zurich	Switzerland

Name	E-mail	Organisation/Company	Country
Wang, Xiaochun	wangx @nefu.edu.cn	Northeast Forestry University	China
Ważny, Tomasz	twazny @umk.pl	Nicolaus Copernicus University	Poland
Weidemueller, Julia	julia.weidemueller @gmx.de	University of Cologne	Germany
Wojtan, Rafał	rwojtan @wl.sggw.pl	Warsaw University of Life Sciences – SGGW	Poland
Wongchai, Chatchawal	wongchaimee2110 @gmail.com	University of Phayao	Thailand
Yermokhin, Maxim	yermaxim @yahoo.com	Institute of Experimental Botany	Belarus
Zafirov, Nikolay, Georgiev	niki.zafirov @gmail.com	University of Forestry, Sofia	Bulgaria
Zeidler, Aleš	zeidler @fld.czu.cz	Czech University of Life Sciences Prague	Czech Republic
Zhao, Binqing	kdoodk @nefu.edu.cn	Northeast Forestry University	China
Zharnikov, Zakhar, Yurievich	mayasidorova12 @gmail.com	Siberian Federal University	Russia
Zielonka, Tomasz	t.zielonka @botany.pl	Pedagogical Univeristy of Cracow	Polska
Zunde, Māris	zunde @lanet.lv	University of Latvia	Latvia
Žmegač, Anja	azmegac @sumfak.hr	University of Zagreb	Croatia

Title: Book of Abstracts. EuroDendro Conference 2019, 9–13 September, 2019, Brno, Czech Republic

Editors: Vladimír Gryc, Kyriaki Giagli, Tomáš Kolář, Eva Koňasová, Michal Rybníček, Hanuš Vavrčík

Publisher: Mendel University in Brno, Zemědělská 1, 61300 Brno, Czech Republic

Press: Mendel University in Brno Publishers, Zemědělská 1, 61300 Brno

Number of pages: 158

Number of prints: 150

Edition, Year of issue: 1st, 2019

ISBN 978-80-7509-676-0