Monitoring radial growth and tree anatomy in relation to climate change

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Climate change and forests

Climate change and subsequent increase in frequency and intensity of extreme climatic events will affect forest vitality and production (carbon sequestration), and consequently also wood quality (COST STREeSS, IPCC 2014).

A major task of our society is to manage forests in a way that their resources are preserved to meet future generation needs (Forest Europe et al. 2015), however anticipated environmental changes are making this task extremely challenging (Sass-Klaassen et al. 2016).

To guide sustainable forest management, forest researchers are asked to provide concrete answers about forest resilience in response to expected climatic trends and extreme climatic events (Lindner et al., 2014). This is not an easy task, because responses of trees and forest ecosystems to environmental conditions are often non-linear and moreover vary on spatial and temporal scales (Smith 2011; Anderreg et al., 2012; Reichstein et al., 2013, Sass-Klaassen et al. 2016).
A Large and Persistent Carbon Sink in the World’s Forests

Fig. 1. Carbon sinks and sources (Pg C year^{-1}) in the world’s forests. Colored bars in the down-facing direction represent C sinks, whereas bars in the upward-facing direction represent C sources. Light and dark purple, global established forests (boreal, temperate, and intact tropical forests); light and dark green, tropical regrowth forests after anthropogenic disturbances; and light and dark brown, tropical gross deforestation emissions.
On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene

Fig. 2. Locations of substantial drought- and heat-induced tree mortality around the globe since 1970, documented by peer-reviewed studies. Global forest cover (dark green) and other wooded regions (light green) based on FAO (2005). Studies compiled through 2009 (red dots) are summarized and listed in Allen et al. (2010). Additional localities, documented by mostly post-2009 studies, include: the white dots and oval shapes derived from Fig. 4-7 and its associated caption in IPCC (2014); and the black dots reported from other recent publications, listed below. References documenting the most recent localities (black dots)
Without a sound understanding of the tree-environmental interactions, future projections will have large uncertainties.
Tree (wood) response to changing climatic and environmental conditions

Genes

Man

Environment

WOOD FORMATION

WOOD STRUCTURE

WOOD PROPERTIES

END-USE OF WOOD (quality)
Wood formation monitoring

• Wood is the main terrestrial biotic reservoir for long-term carbon sequestration, and its formation in trees consumes around 15% of anthropogenic carbon dioxide emissions each year (Pan et al. 2011).

• A detailed mechanistic representation of when and how carbon is sequestered into the wood during the growing season provides crucial information on a major carbon flux and storage component of forest ecosystems. Such information is essential for further developing the process-based biosphere models to better constrain modern carbon budgets and to predict future carbon–climate interactions (Cuny et al. 2015).
Radial growth monitoring in Slovenia

- *Fagus sylvatica*, 2008- onwards
- *Picea abies*, 2009- onwards

65% of the Slovenian woodstock

In collaboration with the University of Ljubljana, Biotechnical Faculty, Dept. Wood Science and Technology
The effect of climate on forest productivity and wood quality

K. Eler
Woody biomass production lags stem-girth increase by over one month in coniferous forests

Figure 3 | Delay between xylem size increase and woody biomass production for the major coniferous forest biomes of the Northern Hemisphere. Different letters above bars indicate significant differences (P < 0.05, one-way analysis of variance with Tukey post-hoc test, n = 213).

These time lags question the extension of the equivalence between stem size increase and woody biomass production to intra-annual time scales. They also suggest that these two growth processes exhibit differential sensitivities to local environmental conditions. Indeed, in the well-watered French sites the seasonal dynamics of stem-girth increase matched the photoperiod cycle, whereas those of woody biomass production closely followed the seasonal course of temperature. We suggest that forecasted changes in the annual cycle of climatic factors may shift the phase timing of stem size increase and woody biomass production in the future.

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Existing scientific research and education cooperation at international level (particularly in SEE)
Scientific publications

Pattern of xylem phenology in conifers of cold ecosystems at the Northern Hemisphere

Scientific publications

Woody biomass production lags stem-girth increase by over one month in coniferous forests

Scientific publications

A meta-analysis of cambium phenology and growth: linear and non-linear patterns in conifers of the northern hemisphere

Scientific publications

Critical temperatures for xylogenesis in conifers of cold climates

Scientific publications
Scientific publications

Croatia
GRIČAR, Jožica, JAGODIC, Špela, ŠEFC, Bogoslav, TRAJKOVIĆ, Jelena, ELER, Klemen. Can the structure of dormant cambium and the widths of phloem and xylem increments be used as indicators for tree vitality?. European journal of forest research (Print), ISSN 1612-4669, 2014, vol. 133, iss. 3, pp. 551-562, doi: 10.1007/s10342-014-0784-8

Czech Republic
GIAGLI, Kyriaki, GRIČAR, Jožica, VAVRČÍK, Hanuš, MENŠÍK, Ladislav, GRYC, Vladimir. The effects of drought on wood formation in Fagus sylvatica during two contrasting years. IAWA journal, 2016, vol. 37, iss. 2, pp. 332-348


Poland

Existing scientific research and education cooperation with researches from China

Prof. Eryuan Liang and his team

- Key Laboratory of Alpine Ecology and Biodiversity, Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100085, China

- CAS Center for Excellence in Tibetan Plateau Earth Sciences, Beijing 100101, China
Scientific publications

Critical minimum temperature limits xylogenesis and maintains treelines on the southeastern Tibetan Plateau

Xiaoxia Li, Eryuan Liang, Jozica Gričar, Sergio Rossi, Katarina Čufar, Aaron M. Ellison

Is precipitation a trigger for the onset of xylogenesis in Juniperus przewalskii on the north-eastern Tibetan Plateau?

Ping Ren, Sergio Rossi, Jozica Gricar, Eryuan Liang, and Katarina Cufar

Age dependence of xylogenesis and its climatic sensitivity in Smith fir on the south-eastern Tibetan Plateau

Xiaoxia Li, Eryuan Liang, Jožica Gričar, Peter Prislan, Sergio Rossi, and Katarina Čufar
Main ambition is to combine state-of-the-art knowledge and techniques in tree anatomy in the search for new approaches and improvements in:

a) wood and bark identification and creating a database of qualitative and quantitative anatomical data of stem and root samples for temperate hardwoods and softwoods (e.g. for GTTN bank);

b) investigation of development and structure of tissues (wood, cambium, bark, etc.) in different tree parts of different tree species, and

c) to accumulate and transfer make known information on the anatomical characteristics of woods that may affect their utilization potential.
Dendro group – Topics for potential future collaboration

- Development of long chronologies of different tree species in the W Balkan region
- Climate reconstruction and study of tree response to climate and other environmental factors including human induced climate change
- Stable isotope dendrochronology
- Isoscapes and identification of the wood origin (in cooperation with wood anatomy and genetics) - GTTN

Selected References:


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Dendro group – international collaboration

For more information contact: Prof. Tom Levanic; tom.levanic@gozdis.si
Current cooperation in international projects in the SEE region and areas for future collaboration

Problem identification:
Forest-wood based industry has great potential, however for optimal wood exploitation the information on available quantity and quality of resources is crucial.
**ID:WOOD: Clustering Knowledge, Innovation and Design in the SEE WOOD sector (EU SEE Interreg project; Lead partner, 01/10/2012–30/09/2014 SEE/D/0227/1.2/X; cca 1.7 mio €)**

The project **ID:WOOD aimed to** promote and foster innovation and competitiveness of SMEs in the wood sector in the SEE area by sharing and transferring technical and organizational know-how.

### Number of partners from EU

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<th>Country</th>
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<tbody>
<tr>
<td>Austria</td>
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<td>Bulgaria</td>
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<td>Slovenia</td>
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### Number of partners from Non EU

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<td>Bosnia and Herzegovina</td>
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<td>Croatia</td>
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<td>Serbia</td>
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**Total number of PPs** 15
FORESDA: Forest-based cross-sectoral value chains fostering innovation and competitiveness in the Danube region (EU DTP Interreg project, cca 2.1 mio €; 01/01/2017–30/06/2019 DTP1-383-1.1)

FORESDA’s main objective is to support the transformation of traditional forest-based industries into sustainable manufacturing areas by an innovative cross-sectoral and transnational approach.

Partner countries: Germany, Slovenia, Austria, Hungary, Croatia, Romania, Bulgaria, Serbia, Bosnia Herzegovina

Danube Region:
- Characterized by 41.5% woodland
- Traditional wood sector
- Mainly SME’s and micro firms (with less than 10 employees)
Thank you!

For further information:

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