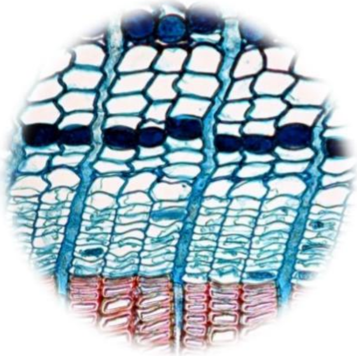 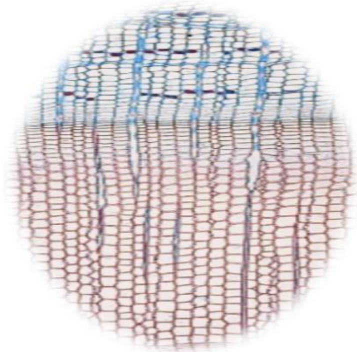 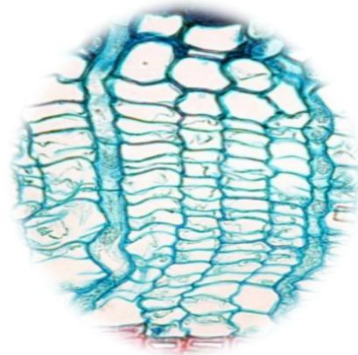 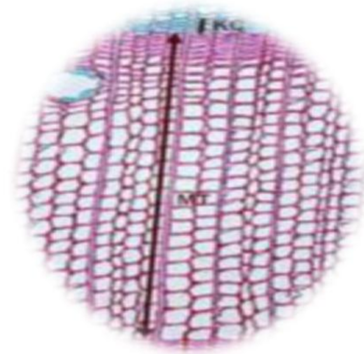

Monitoring radial growth and tree anatomy in relation to climate change

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International Conference on China-CEECs, Forestry Research and Education Cooperation, 29-31 October, 2017, Beijing, China

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China and CEEC FORESTRY

Climate change and forests

13 FEBRUARY 2014 | VOL 506 | NATURE | 153

Managing forests in uncertain times

Increasing both forest stocks and timber harvest will buy time while we learn more about how trees absorb carbon, say **Valentin Bellassen** and **Sebastiaan Luyssaert**.

- 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

Pan et al. 2011 Science

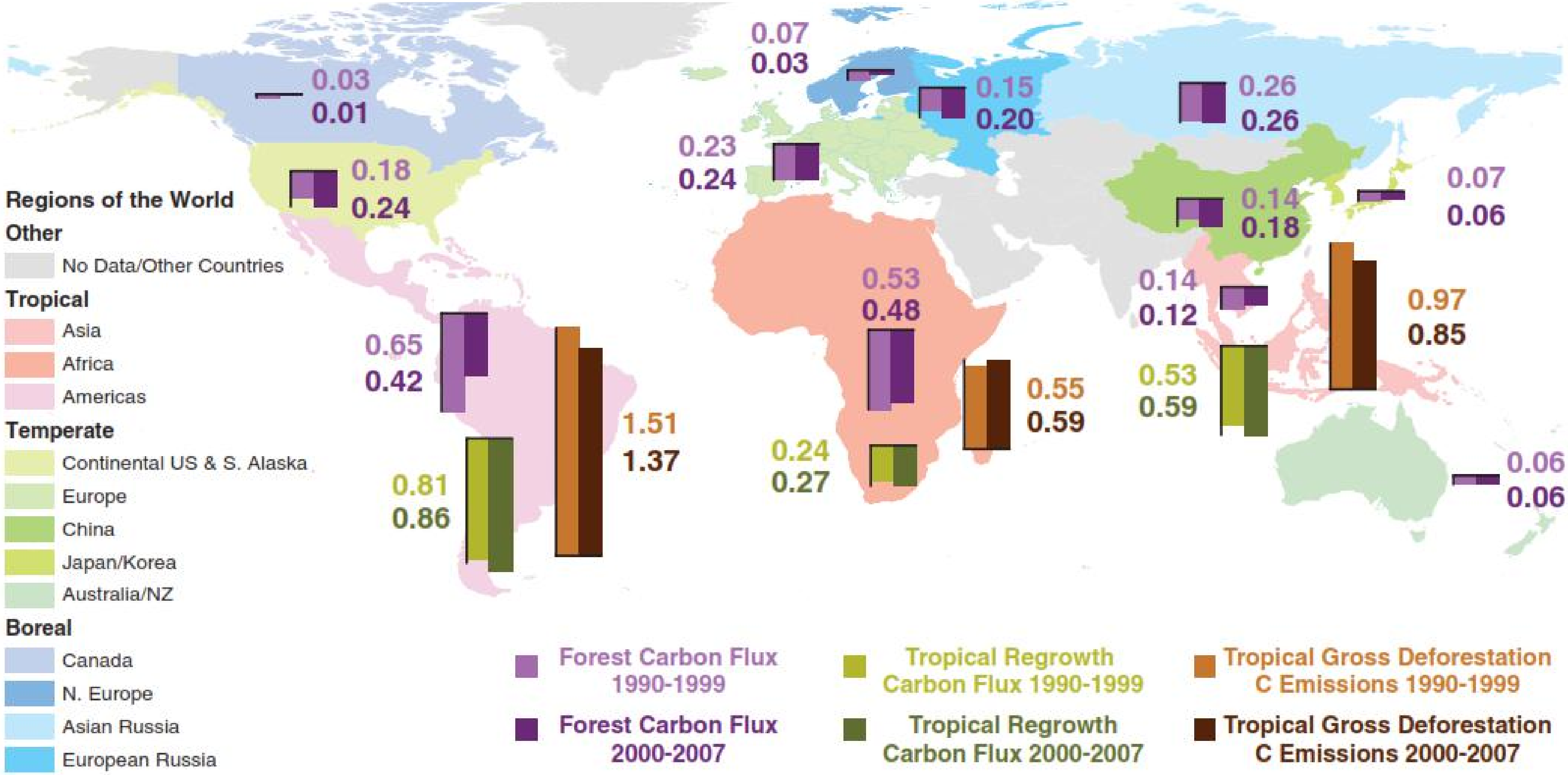


Fig. 1. Carbon sinks and sources (Pg C year^{-1}) in the world's forests. Colored bars in the down-facing direction represent C sinks, whereas bars in the upward-facing direction represent C sources. Light and dark purple, global established forests (boreal, temperate, and intact tropical forests); light 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

Allen et al. 2015

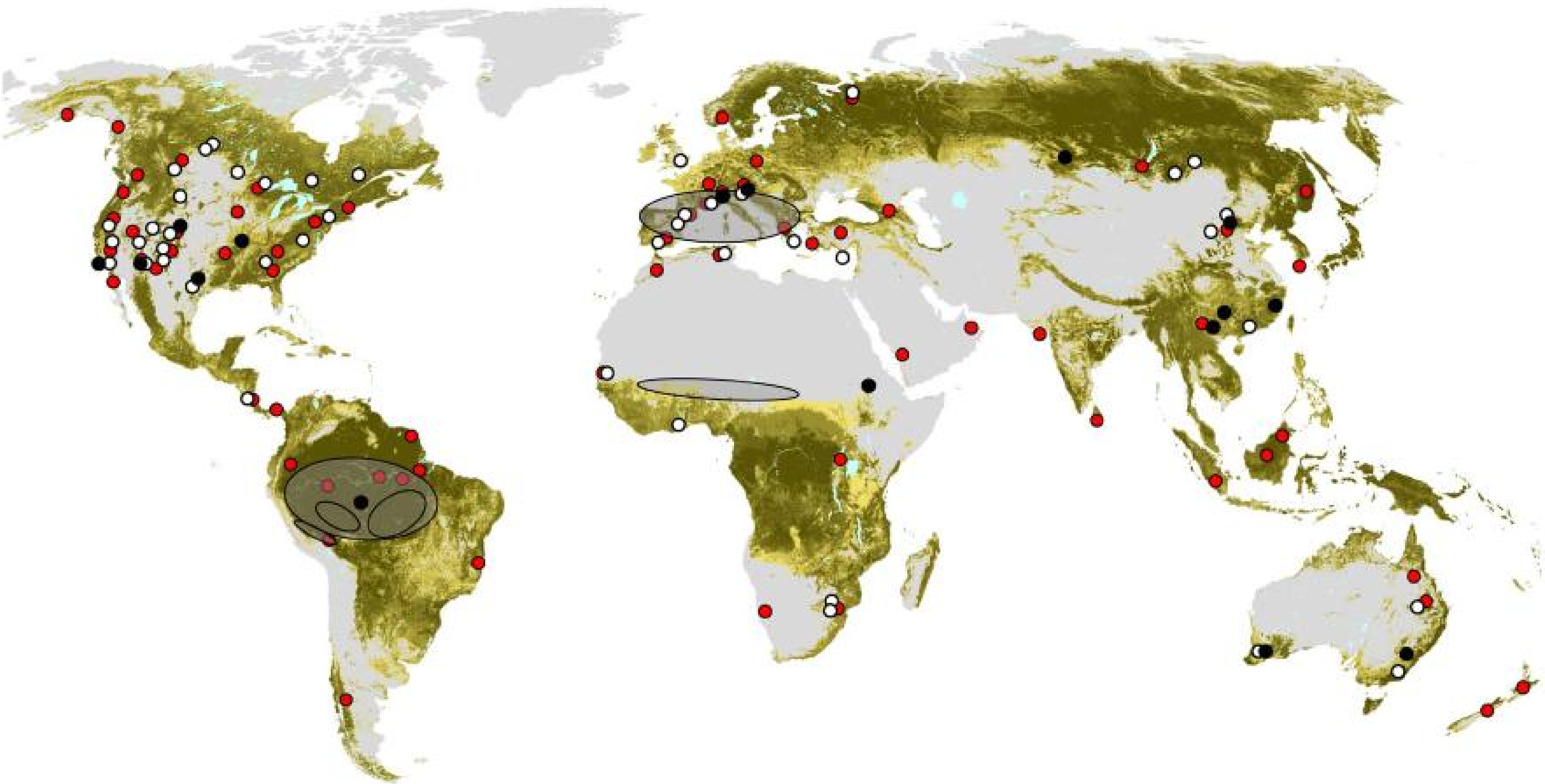


Fig. 2. Locations of substantial drought- and heat-induced tree mortality around the globe since 1970, documented by peer-reviewed studies. Global forest cover (dark green) and other wooded regions (light green) based on FAO (2005). Studies compiled through 2009 (red dots) are summarized and listed in 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)

FPS COST Action FP1106 STReESS - Studying Tree Responses to extreme Events: a SynthesiS

frontiers in Plant Science

OPINION
published: 21 July 2016
doi: 10.3389/fpls.2016.01069

A Tree-Centered Approach to Assess Impacts of Extreme Climatic Events on Forests

Ute Sass-Klaassen[1], Patrick Fonti[2], Paolo Cherubini[2], Jožica Gričar[3], Elisabeth M. R. Robert[4,5,6], Kathy Steppe[7] and Achim Bräuning[8]*

[1] Forest Ecology and Forest Management Group, Wageningen University, Wageningen, Netherlands, [2] Landscape Dynamics Unit, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland, [3] Department of Forest Yield and Silviculture, Slovenian Forestry Institute, Ljubljana, Slovenia, [4] CREAF, Cerdanyola del Vallès, Spain, [5] Laboratory of Plant Biology and Nature Management, Vrije Universiteit Brussel, Brussels, Belgium, [6] Laboratory of Wood Biology and Xylarium, Royal Museum for Central Africa, Tervuren, Belgium, [7] Laboratory of Plant Ecology, Department of Applied Ecology and Environmental Biology, Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium, [8] Department of Geography and Geosciences, Friedrich-Alexander-University Erlangen-Nuremberg, Erlangen, Germany

Keywords: climate change, future forests, tree, mechanistic understanding, structure-function relationships, long-term monitoring, intra-annual resolution, resilience

Without a sound understanding of the tree-environmental interactions, future projections will have large uncertainties.

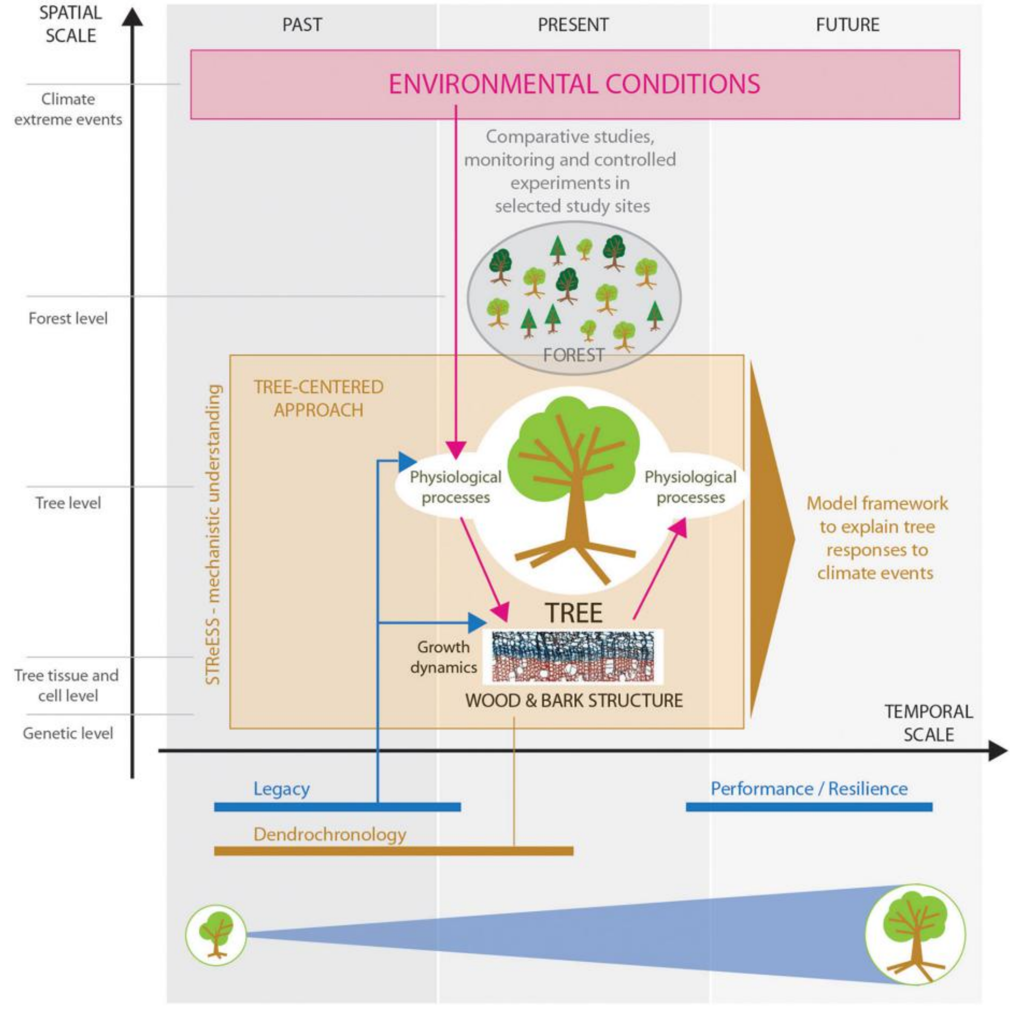
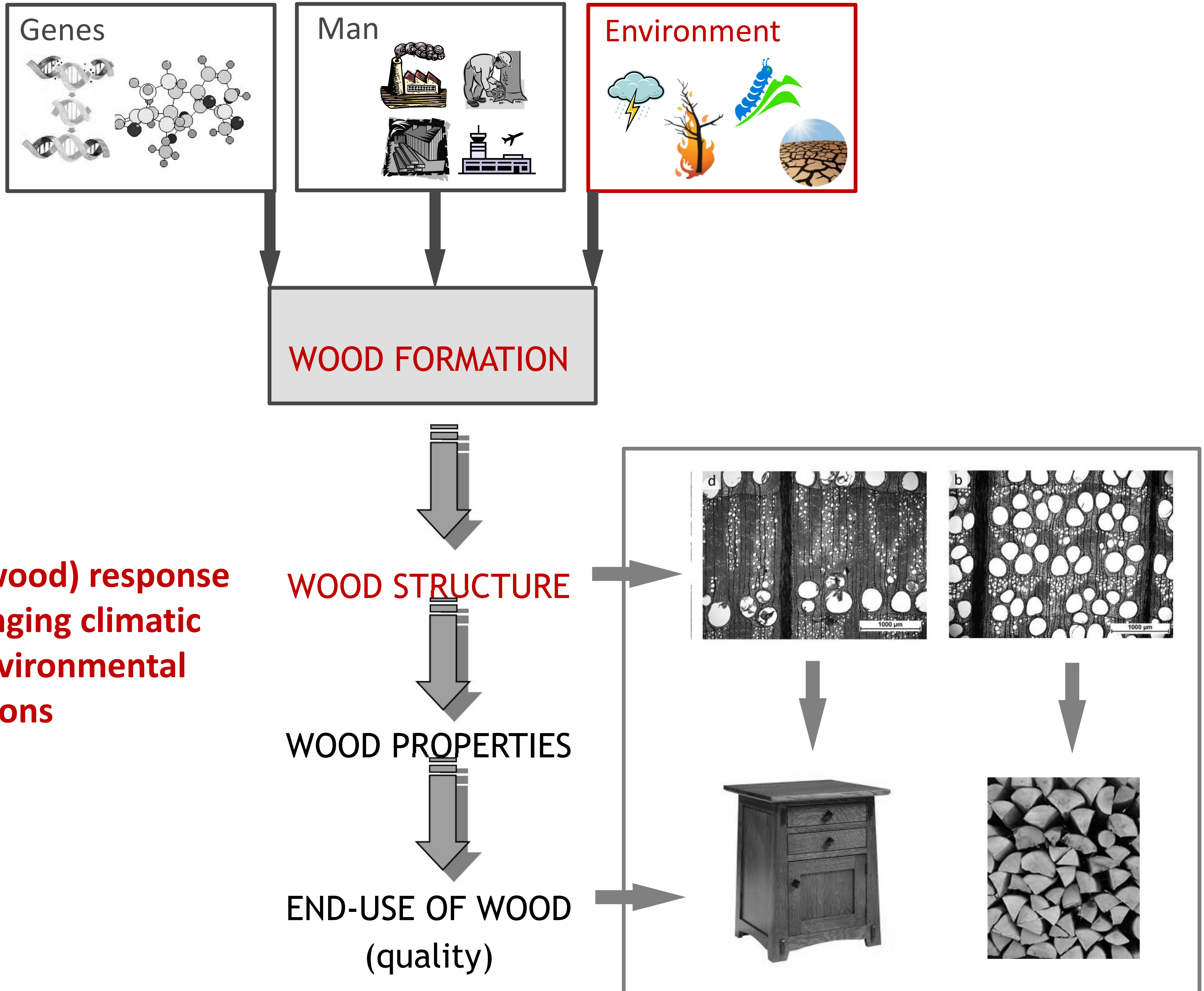


FIGURE 1 | Schematic of the tree-centered approach applied by STReESS to enhance mechanistic understanding. The approach consists of the following interlinked elements: (1) Environmental conditions affect physiological processes, which drive growth dynamics, and results in specific wood and bark structure. (2) Quantity and structure of newly formed wood as assessed by dendrochronology affects whole-tree physiological functioning and performance. (3) Legacy of past environmental conditions and extreme events is imprinted in wood structure, influencing tree functioning, and todays' tree performance. This is important to assess tree resilience ability. (4) Selection of comparative studies, monitoring, and controlled experiments allow model testing and validation in specific contexts. All four elements are important to assess non-linear trigger-response relations and enable to create a model framework to explain and evaluate tree responses to climate events.

Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, Ukrain, USA

Tree (wood) response to changing climatic and environmental conditions



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).

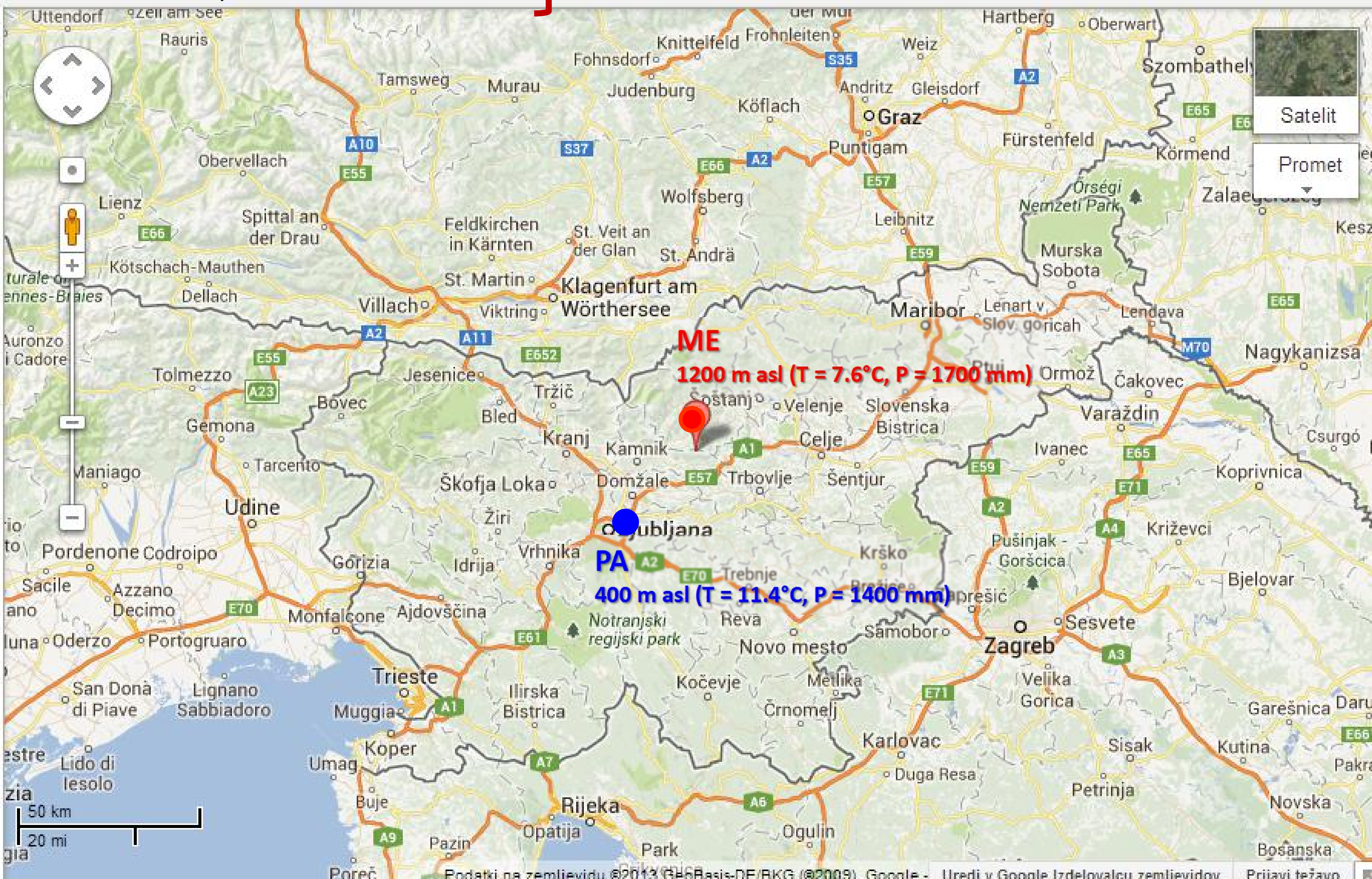
- A detailed mechanistic representation of when and how carbon is sequestered into the wood during the growing season provides crucial information on a major carbon flux and storage component of forest ecosystems. Such information is essential for further developing the process-based biosphere models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

Radial growth monitoring in Slovenia

In collaboration with the University of Ljubljana, Biotechnical Faculty,
Dept. Wood Science and Technology

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

65 % of the Slovenian woodstock



The effect of climate on forest productivity and wood quality

K. Eler

GOZDARSKI INŠTITUT SLOVENIJE
SLOVENIAN FORESTRY INSTITUTE

nature plants
LETTERS
PUBLISHED: 26 OCTOBER 2015 | ARTICLE NUMBER: 15160 | DOI: 10.1038/NPLANTS.2015.160

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

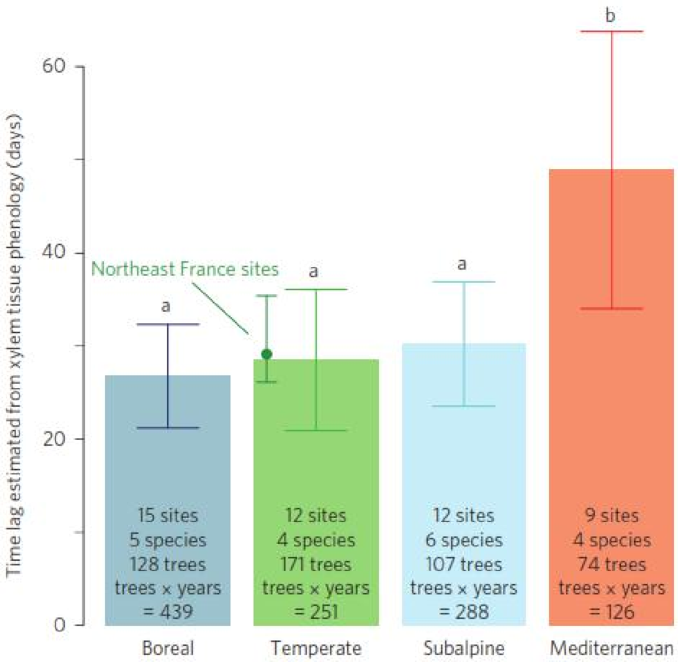


Figure 3 | Delay between xylem size increase and woody biomass production for the major coniferous forest biomes of the Northern Hemisphere. Different letters above bars indicate significant differences ($P < 0.05$, one-way analysis of variance with Tukey post-hoc test, $n = 213$).

These time lags question the extension of the equivalence between stem size increase and woody biomass production to intra-annual time scales[3–6]. 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[7] may shift the phase timing of stem size increase and woody biomass production in the future.

Henri E. Cuny[1,2,3]*, Cyrille B. K. Rathgeber[1,2], David Frank[3,4], Patrick Fonti[3], Harri Mäkinen[5], Peter Prislan[6], Sergio Rossi[7,8], Edurne Martinez del Castillo[9], Filipe Campelo[10], Hanuš Vavrčík[11], Jesus Julio Camarero[12], Marina V. Bryukhanova[13,14], Tuula Jyske[5], Jožica Gričar[6], Vladimír Gryc[11], Martin De Luis[9], Joana Vieira[10], Katarina Čufar[15], Alexander V. Kirdyanov[13,14], Walter Oberhuber[16], Vaclav Treml[17], Jian-Guo Huang[8], Xiaoxia Li[18], Irene Swidrak[16], Annie Deslauriers[7], Eryuan Liang[18], Pekka Nöjd[5], Andreas Gruber[16], Cristina Nabais[10], Hubert Morin[7], Cornelia Krause[7], Gregory King[19] and Meriem Fournier[1,2]

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

Scientific publications

Global Change Biology

Global Change Biology (2016) **22**, 3804–3813, doi: 10.1111/gcb.13317

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

SERGIO ROSSI[1,2,3], TOMMASO ANFODILLO[4], KATARINA ČUFAR[5], HENRI E. CUNY[6], ANNIE DESLAURIERS[1], PATRICK FONTI[7], DAVID FRANK[7,8], JOŽICA GRIČAR[9], ANDREAS GRUBER[10], JIAN-GUO HUANG[2,3], TUULA JYSKE[11], JAKUB KAŠPAR[12], GREGORY KING[7,8,*], CORNELIA KRAUSE[1], ERYUAN LIANG[13], HARRI MÄKINEN[11], HUBERT MORIN[1], PEKKA NÖJD[11], WALTER OBERHUBER[10], PETER PRISLAN[9], CYRILLE B.K. RATHGEBER[6], ANTONIO SARACINO[14], IRENE SWIDRAK[10] and VÁCLAV TREML[12]

nature plants

LETTERS

PUBLISHED: 26 OCTOBER 2015 | ARTICLE NUMBER: 15160 | DOI: 10.1038/NPLANTS.2015.160

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

Henri E. Cuny *et al.**

Annals of Botany Page 1 of 10
doi:10.1093/aob/mct243, available online at www.aob.oxfordjournals.org

ANNALS OF BOTANY Founded 1887

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

Sergio Rossi[1,*], Tommaso Anfodillo[2], Katarina Čufar[3], Henri E. Cuny[4], Annie Deslauriers[1], Patrick Fonti[5], David Frank[5,6], Jožica Gričar[7], Andreas Gruber[8], Gregory M. King[5,6], Cornelia Krause[1], Hubert Morin[1], Walter Oberhuber[8], Peter Prislan[3] and Cyrille B. K. Rathgeber[4]

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2008) **17**, 696–707

RESEARCH PAPER

Critical temperatures for xylogenesis in conifers of cold climates

Sergio Rossi[1,2,3*], Annie Deslauriers[1,3], Jožica Gričar[4], Jeong-Wook Seo[5], Cyrille BK Rathgeber[2], Tommaso Anfodillo[1], Hubert Morin[3], Tom Levanic[4], Primož Oven[6] and Risto Jalkanen[7]

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

GIAGLI, Kyriaki, GRIČAR, Jožica, VAVRČÍK, Hanuš, GRYC, Vladimir. Nine-year monitoring of cambial seasonality and cell production in Norway spruce. IForest, 2016, vol. 9, iss. Jun, pp. 375-382, doi: 10.3832/ifor1771-008

GRIČAR, Jožica, PRISLAN, Peter, DE LUIS, Martin, GRYC, Vladimir, HACUROVÁ, Jana, VAVRČÍK, Hanuš, ČUFAR, Katarina. Plasticity in variation of xylem and phloem cell characteristics of Norway spruce under different local conditions. Frontiers in plant science, 2015, vol. 6, article 730, 13 pp., doi: 10.3389/fpls.2015.00730.

GRIČAR, Jožica, PRISLAN, Peter, GRYC, Vladimir, VAVRČÍK, Hanuš, DE LUIS, Martin, ČUFAR, Katarina. Plastic and locally adapted phenology in cambial seasonality and production of xylem and phloem cells in Picea abies from temperate environments. Tree physiology, 2014, vol. 34, no. 8, pp. 869-881, doi: 10.1093/treephys/tpu026

Poland

KOPROWSKI, Marcin, OKOŃSKI, Bernard, GRIČAR, Jožica, PUCHAŁKA, Radosław. Streamflow as an ecological factor influencing radial growth of European ash. Ecological Indicators, 2017, in press.

PUCHAŁKA, Radosław, KOPROWSKI, Marcin, GRIČAR, Jožica, PRZYBYLAK, Rajmund. Does tree-ring formation follow leaf phenology in Pedunculate oak (Quercus robur L.)?. European journal of forest research (Print), 2017, vol. 136, iss. 2, pp. 259-268.

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

Contents lists available at ScienceDirect

Science Bulletin

journal homepage: www.elsevier.com/locate/scib

Article

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

Xiaoxia Li [a], Eryuan Liang [a,b,*], Jozica Gričar [c], Sergio Rossi [d,e], Katarina Čufar [f], Aaron M. Ellison [g]

Annals of Botany **115**: 629–639, 2015
doi:10.1093/aob/mcu259, available online at www.aob.oxfordjournals.org

ANNALS OF BOTANY Founded 1887

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

Ping Ren[1,2,3], Sergio Rossi[4], Jozica Gricar[5], Eryuan Liang[1,2,*] and Katarina Cufar[6]

Tree Physiology 00, 1–9
doi:10.1093/treephys/tps113

Research paper

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

Xiaoxia Li[1], Eryuan Liang[1,5], Jožica Gričar[2], Peter Prislan[3], Sergio Rossi[4] and Katarina Čufar[3]

Laboratory of Wood Anatomy – Suggestion for future collaboration

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.

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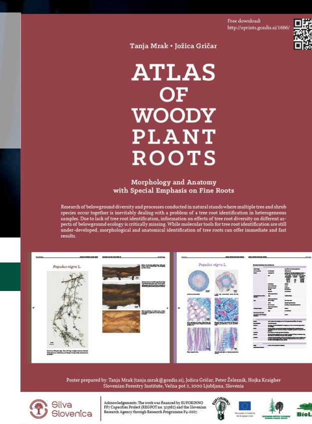

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This project is funded by the European Union

EUFORINNO RegPot No. 315982

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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POLJANŠEK, Simon, LEVANIČ, Tom, BALLIAN, Dalibor, JALKANEN, Risto. Tree growth and needle dynamics of P. nigra and P. sylvestris and their response to climate and fire disturbances. Trees, ISSN 0931-1890, 2015, vol. 29, no. 3, str. 683-694, ilustr

STOJANOVIĆ, Dejan, LEVANIČ, Tom, MATOVIĆ, Bratislav, PLAVŠIĆ, Jasna. Prirast i vitalnost hrasta lužnjaka u Sremu sa aspekta promene vodostaja Save = Trends in growth and vitality of Pedunculate oak forests in Srem from the aspect future Sava river water level change. Topola : časopis za unapređenje topolarstva Jugoslavije, ISSN 0563-9034, 2014, no. 193/194, str. 107-115, ilustr.

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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	
Austria	1
Bulgaria	1
Hungary	1
Italy	3
Romania	1
Slovenia	4
Number of partners from Non EU	
Bosnia and Herzegovina	2
Croatia	1
Serbia	1
Total number of PPs	15

SOUTH EAST EUROPE
Jointly for our common future

ID:WOOD

Programme co-funded by the EUROPEAN UNION

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

Interreg
EUROPEAN UNION
Danube Transnational Programme
FORESDA

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!

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China and CEEC FORESTRY