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Tree Ring Research – Understanding Changing Environments

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The 7th International Conference on Dendrochronology – Cultural Diversity, Environmental Variability – took place in Beijing, China from 11 to 17 June 2006. More than two hundred presentations and around 100 posters covered all aspects of tree ring research including chemical and physical properties of tree rings; the biological basis of tree rings; climatology and hydrology; ecology; geology; the development of methods and models; archaeology and cultural studies as well as interdisciplinary studies. Special attention was given to the different uses of tree ring analysis in meteorology, geosciences and history.

Tree rings are a unique data source covering a wide range in space and time. Tree rings serve as environmental archives as they reflect environmental conditions and their changes. They allow a detailed reconstruction of tree growth – trunk, branches, roots and even needles. In times of fast environmental changes these archives become increasingly important. Consequently, the amount, length and quality of dendrochronologies is increasing all over the world, as possibilities to use them get continuously better and historical dendrochronology is linked to climatology, ecology and wood biology.

Studies of tree ring **chronologies of thousands of years** are used for long-term meteorological observations, for example, giving evidence of temperature and precipitation developments over the centuries. This is of great help for understanding changes in biodiversity.

The **variety of innovative applications** of dendrochronology for historical purposes shows that this is far more than a dating method. Dendro-provenancing is useful for identifying where the wood used in historical buildings, for example, comes from and which samples come from the same tree.

Dendroecology was defined as the science that uses tree rings dated to their exact year of formation to analyze temporal and spatial relationships between living organisms and their environment. Dendroecology is applied in many fields such as wildfire dynamics, insect dynamics, forest stand dynamics, forest management, environmental quality, human disturbances as well as in wildlife ecology.



Photo by Gerda Wolfrum, IUFRO Headquarters

In geosciences, dendroecology is also becoming increasingly important in reconstructing earth surface processes as it facilitates, among other things, the dating of land surfaces and the reconstruction of variable hydrological conditions in soils.

In all, tree ring research helps to understand environmental conditions and mechanisms of tree reaction. However, there is still a **huge potential for interdisciplinary cooperation** which is not yet exploited on an international level. This cooperation should lead to a more comprehensive understanding and provide more realistic and reliable information for decision support in the future.



Photo by Kaisu Makkonen-Spiecker: Conference Co-Chairs (from right): Peter Brown, President of the TRS, Qi-Bin Zhang, Institute of Botany, Chinese Academy of Sciences, and Heinrich Spiecker, President of the ATR.

The conference was organized and hosted by the Institute of Botany, Chinese Academy of Sciences in conjunction with [IUFRO Working Party 5.01.07](#). Tree Ring Analysis under the auspices of the Tree-Ring Society (TRS) and the European Association for Tree-Ring Research (ATR). It was also sponsored by the National Natural Science Foundation of China (NSFC), the Chinese Academy of Sciences and the Past Global Changes (PAGES). Nearly 300 scientists from 35 countries participated. Rovaniemi, Finland, was agreed to be the venue of the next international conference of dendrochronology to be held in 2010. [Full report.](#)

What does it mean?

Dynamic disciplines such as tree-ring science are fruitful grounds for newly emerging concepts, for which printed or online definitions may be outdated, or not available yet. This is why this month's definitions were taken from the mouth of the very experts who stand for them.

If you would also like to contribute your expert knowledge, join the IUFRO Directory of Experts (<http://www.wsl.ch/forest/risks/iufro/>) and help IUFRO make expert knowledge available!

stable isotope dendrochronology

An application of dendrochronology that uses stable (non radioactive) isotopic compositions of tree-ring wood and cellulose to reconstruct past environmental conditions, for example historical atmospheric temperatures, or to study the effects of environmental changes (climate, air pollutants or increasing carbon dioxide) on trees. Commonly analyzed stable isotopes include carbon, oxygen, hydrogen and in wood nitrogen and sulfur. *(Rolf Siegwolf, Head, Stable Isotopes Research Group, Paul Scherrer Institute, Switzerland)*

By Renate Prüller, Coordinator [SilvaVoc](#) and Michèle Kaennel Dobbertin, Coordinator [IUFRO 6.03.02](#)

dendroprovenancing

Technique based on tree-ring analysis used to identify the geographic origin of timber and historical wooden objects. *(Niels Bonde, Research Lab for Natural Science and Dendrochronology, National Museum Copenhagen, Denmark)*

crossdating

The procedure of matching variations in ring widths or other ring characteristics among tree-ring series, allowing the identification of the exact year in which each tree ring was formed. Crossdating is accomplished in a three-level hierarchy: (1) within series from an individual tree, (2) among series from an individual site, and (3) between sites to establish a regional signal. Crossdating is considered by most dendro-scientists as the fundamental principle of dendro-chronology in its classical definition, but dendro-scientists also recognize the usefulness of counting rings when crossdating is not possible. *(Henri D. Grissino-Mayer, University of Tennessee, Knoxville, USA)*

[More scientific summaries and definitions](#)

Heads of European National Forest Research Institutes Meet in Latvia

The 2nd meeting of directors of European forest research institutes took place in Riga from 3-4 July. IUFRO as a global platform for forest research coordination was represented by Executive Director Peter Mayer. The directors, whose institutes, to a large extent, are IUFRO members, primarily discussed matters relevant in the context of the European Union.

The meeting presented an opportunity to report about the global Director's Forum in Brisbane and to promote the Washington Meeting (18-20 April 2007) of IUFRO 6.06.00

Management of forest research entitled "Forest Research Management in an Era of Globalisation". The meeting will be a key meeting for directors discussing forest research management on the global level for the future.

Furthermore, IUFRO has also offered to contribute to a planned science forum in the frame of the Forest Action Plan on EU level.

7th International Conference on Dendrochronology

– Cultural Diversity, Environmental Variability -

Beijing, China from 11 to 17 June 2006

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Nearly 300 scientists from 35 countries participated in the 7th International Conference on Dendrochronology the main objectives of which were to strengthen communication and cooperation among tree ring researchers all over the world, and to present the state-of-the-science of dendrochronology for better understanding of changing global environments and human cultures. The conference also intended to promote tree ring research and education in China and other Asian countries. More than two hundred presentations and around 100 posters covered all aspects of tree ring research including chemical and physical properties of tree rings; biological basis of tree rings; climatology and hydrology; ecology; geology; development of methods and models; archaeology and cultural studies as well as interdisciplinary studies.

Within the scope of the conference, pre-conference field week was organized by the Tree-Ring Lab at the National University of Mongolia taking place in Bogd Mountain near Ulaanbaatar. The field week focused on interrelations between tree growth and site conditions in natural forests as well as influence of a-biotic and biotic stresses on tree growth. Through mid-conference local excursions, the delegates got a possibility to visit the historical heritages and scenery spots in Beijing including e. g. the Great Wall and the Forbidden City. Finally, several post-conference field excursions were organized e. g. to Tibetan Plateau, addressing the perspectives of cultural diversity and environmental variability in a variety of forest landscapes, cultural heritages, and natural landscapes.

Tree rings as environmental archives: Tree rings are a unique data source covering wide range in space and time, as Heinrich Spiecker, president of the ATR stated in his welcome address: Tree

rings reflect environmental conditions and their changes; they allow a detailed reconstruction of tree growth – trunk, branches, roots and even needles; they form an archive wherever trees form annual rings and where living trees of sub-fossil or fossil wood exist. In times with fast environmental changes these archives become increasingly important. Parallel, tree ring research became even more attractive because of improvements in analytical tools for exploiting data archives, in statistical tools for analyzing growth/environment relation and for special variation, as well as in human beings' understanding of environmental conditions and mechanism of tree reaction. Spiecker concluded that there is a huge potential of interdisciplinary collaboration which is not yet exploited on an international level. This cooperation should lead to a more comprehensive understanding and provide more realistic and reliable information for decision support.

Meteorological observations as a key of tree ring archives: Four thousand years ago, the forest coverage in China was up to 60%, but only 17% by the end of 20th century, equivalent to 61% of the world average. According to DING Yihui, China, biodiversity has been affected as for instance the distribution area of wild camel decreased showing today just small existence in the Northwest of China. Also the speed of grassland degradation has increased in China, the grassland degradation area having been 15 % in the 70s and being 90 % in the 2000s.

Since the 80s, there is a rapid development of the tree ring research in China seen in the continuously increasing number of tree ring studies. In the presentation of DING Yihui, an example of a 2326-year tree ring chronology, as well as a 1437-year precipitation reconstruction in Northeastern Qinghai-Tibetan Plateau were mentioned within the scope of long term meteorological observations. According to these studies, there have been at least four warm periods during the past 2000 years – 1-200 AD, 570-780 AD, 930-1320 AD and 1920 AD-present. During the last 50 years, most regions became warmer, significantly the northern China. More rain was registered in western and southern, more droughts in the North and northeast China. Also the seasonal melting depth of the frozen earth has increased by 0.6 to 1.0 m since 1980's.

An increase in extension and intensity of the warming is forecasted according to the Chinese projection of climate change for the future 50-100 years. Precipitation will increase as well, with greater increase in Northwest China. As a consequence, the glacier will further shrink and snow line will ascend so that glaciers in China would be reduced by half till 2050s. Deficiency of water supply, degradation of water quality, as well as the dropping lake level and the shrinking lake area were shown to be further consequences of this meteorological development. Contradiction between

supply and demand of water resources may get more obvious in China. According to DING Yihui, Chinese rapidly progressing meteorological development will be beneficial for the tree ring research so that “meteorological observation gives tree rings life”.

Chronology as a “living organism”: Katarina Čufar, Slovenia gave an excellent literature overview of the use of dendrochronology for historical purposes with many innovative applications showing that dendrochronology is far more than only a dating method: chronology is a »living organism«. She mentioned not only millennial long chronologies in South America, by 5666 year-long chronologies in South Africa, a 4000 year Kauri (*Agathis australis*) chronology prospected in New Zealand, more than 7500 years old *Pinus sylvestris* chronologies in Fennoscandia, a 7000 year-long continuous chronology of *Pinus cembra* and 3474 year-chronology of *Larix decidua* in Austria, but also the 10.429 year-long oak chronology in Hohenheim, Germany – the longest chronology in the world, prolonged with pine chronology. The single chronologies were presented by the authors in different sessions during the conference.

According to Čufar, amount, length and quality of chronologies is increasing all over the world, as possibilities to use dendrochronology get continuously better and historical dendrochronology get linked to climatology, ecology and wood biology. She showed that application of dendrochronology in cultural heritage is present everywhere: in buildings and constructions like churches, temples, monasteries, castles, palaces, etc. Finally, she addressed the issue of dendroprovenancing with the question, where does the wood to be researched come from, as well as which samples come from the same tree. She concluded that China with its millennia-long history of rich and highly developed culture, as well as Beijing with its famous Forbidden City, in particular, was an excellent venue for the conference to disseminate the message that dendroarcheology and dendrochronology in cultural heritage is still alive and in progress, even when archaeologists and art historians, as well as dendrochronologists may not be fully aware of their potentials.

Tree rings in geosciences: Tree ring analysis was regarded by Holger Gärtner, Switzerland, in his overview presentation as one of the most accurate dating methods in geosciences becoming increasingly important in reconstructing earth surface processes. Rapid development of various kind of dendroecological techniques in all subfields of geosciences has facilitated e. g. the dating of land surfaces, the reconstruction of variable hydrological conditions in soils, dating of volcanic eruptions and of widespread effects of earthquakes and the reconstruction of glacial fluctuations as well as the reconstructing frequencies of geomorphic processes such as rock fall, landslides, debris flows and

creeping slopes on permafrost. Event related disturbances (scars, tilting, bend of stem, visible/not visible root disturbances etc.) and growth responses like eccentricity, growth release, callous tissue, anatomical changes in annual rings of roots, growth suppression in stem were shown by Gärtner as well.

Forward thinking for a retrospective science: This was the motto of Henri Grissino-Mayer, Knoxville, USA, who presented future expectations of dendroecology defining it as the science that uses tree rings dated to their exact year of formation to analyze temporal and spatial relationships between living organisms and their environment. He showed the diversity of dendroecology through applications and innovations in wildfire dynamics, insect dynamics, forest stand dynamics, forest management, environmental quality, human disturbances as well as in wildlife ecology. Climate and climate change were counted to the interdisciplinary crossovers in dendroecology humans being agents of ecosystem change.

Not to forget – the posters! For a 7638-year-old continuous Scots pine tree-ring record from the tree line area of Northern Fennoscandia tree ring samples were collected from living trees, dead standing logs, old buildings and sub-fossil wood from small lakes, as presented in a poster of Mauri Timonen et al, Finland. This record is used as the main source to study past climate variations showing that ancient timber line was 100-200 m higher and even 80 km further north than today, and summer mean temperatures were 2-4 degree warmer than today. The authors stated, however, that this supra-long pine chronology is not yet long enough to overlap the specific cooling period with an obvious drastic drop of 1-5°C in annual mean temperatures lasting for a few hundred years observed in northern hemisphere about 8200 years ago. But, their future target is to find over 8000-year-old pine mega fossils to analyze from tree rings how Finnish climate changed in those days.

Successful outputs of the conference were e. g. the Chinese decision to establish a new dendrochronological network – *Asian Association for Tree-Ring Research*, and several awards given for the best poster, as well as to outstanding persons, e. g. to Dieter Eckstein, University of Hamburg and to Fritz Schweingruber, WSL Birmensdorf for their merits in dendrochronology. Finally, after an excellent application presented by Kari Mielikäinen, Finland, the delegates decided unanimously for Rovaniemi, Finland, as the venue of the next international conference of dendrochronology to be held in 2010.

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Photo (by Kaisu Makkonen-Spiecker):

Conference Co-Chairs (from right): Peter Brown, President of the TRS, Qi-Bin Zhang, Institute of Botany, Chinese Academy of Sciences, and Heinrich Speiecker, President of the ATR.

