AsianDendro 2019
The 6th Asian Dendrochronology Conference

"A window to the world of Asian Dendrochronology"

Abstracts

Organized by
Birbal Sahni Institute of Palaeosciences
Lucknow, INDIA

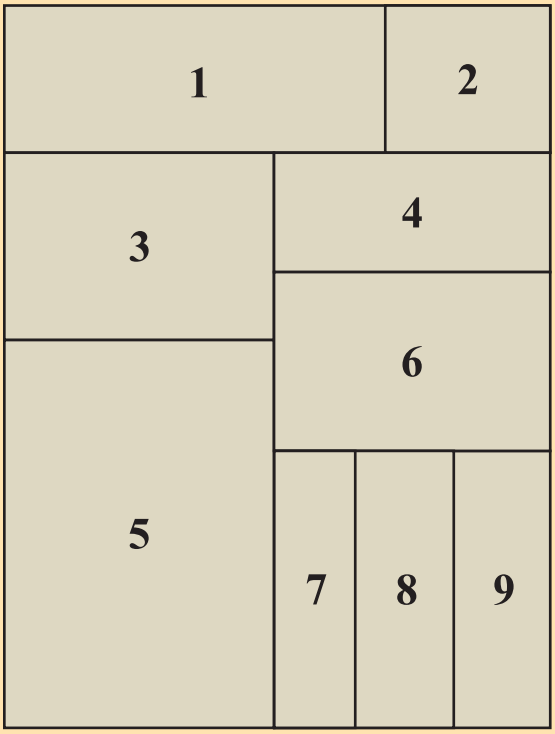
In association with
Asian Dendrochronological Association
(ADA)

November 24 – 30, 2019

Department of Sciences & Technology
Government of India

Ministry of Earth Sciences
Government of India

ASSOCIATION FOR TREE-RING RESEARCH



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सत्यमेव जयते
प्रो. आशुतोष शर्मा
Prof. Ashutosh Sharma

स्वच्छ भारत
एक कदम स्वच्छता की ओर

सचिव
भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
विज्ञान और प्रौद्योगिकी विभाग
Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology

5th November, 2019

MESSAGE

I am pleased to learn that Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow is Organizing the 6th Asian Dendrochronology Conference during November 24-30, 2019. It is also a matter of great encouragement to acknowledge that this will be India's maiden Asian Dendrochronology Conference under the aegis of the Asian Dendrochronological Association (ADA).

Trees record various experiences of their interaction with its external environment throughout their growth period, and with climate more so than others. The records of past climatic conditions have traditionally been extracted from the ring width of those trees that produce annual rings. As a result of the rapid progress and development of the field of dendrochronology, particularly in recent decades, tree-ring studies are no longer limited to ring width and have expanded into various other domains of science apart from palaeoclimatology. I hope and wish that the gathering of tree ring scientists from various corners of the world shall set the stage for many new and exciting developments in Asian dendrochronology and beyond.

I would like to commend the organizers for their monumental feat in bringing the conference to India, and wish the conference a grand success.

(Ashutosh Sharma)

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MESSAGE

I am extremely delighted to learn that the 6th Asian Dendrochronology Conference will be held for the first time in India at the Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow during November 24-30, 2019 under the banner of Asian Dendrochronological Association.

Dendrochronology has made great strides in the application of various methods and techniques on tree-ring records to obtain important climatic and other environmental signals of the past. It has proven to be a significant high-resolution archive for reconstructing climate scenario on a multi-decadal to centennial scales. Tree-rings have archived past extreme natural events that have shaped human civilization and the environment. The congregation of reputed Dendrochronologists under one roof is indeed a wonderful opportunity for young and experienced scientists to learn, acquire, disseminate and exchange the knowledge and skills that have been accumulated from the more than a century long history of dendrochronology.

I sincerely hope that the theme of the conference "*A window to the world of Asian dendrochronology*" will be realized from the fine works of various participants from Asia and elsewhere, dealing with the wide-ranging aspects of dendrochronological research in Asia in particular, and the world.

I would like to convey my best wishes for a very successful and effective conference. I would also like to express my appreciation to the organizers for their sincere efforts in making the conference a success.

(M. Rajeevan)

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प्रो. अजय के. सूद
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Prof. Ajay K. Sood
President

MESSAGE

The Asian Dendrochronological Association has been organizing the Asian Dendro Conference since the year 2007. For the first time, the Birbal Sahni Institute of Palaeosciences is hosting the 6th Asian Dendrochronology Conference during November 24-30, 2019 in Lucknow, India.

The rings produced by certain trees during their lifetime contain high resolution palaeo-environmental records at the annual to seasonal scale that enable us to take a glimpse of various aspects of earth's environment spanning several millennia into the past. In India for instance, tree rings have allowed us to study over 1000 years of past climate variability in the Western Himalayas.

I am confident that this conference will provide the necessary exposure especially for the budding scientists to interact, learn and exchange ideas with eminent tree ring scientists from all over the world. Such academic events are a part and parcel of research and are essential in acquainting the researchers with the latest developments that dendrochronology has to offer.

I comprehend that that the conference would strengthen and promote collaborations among the various institute and universities and encourage breakthroughs in scientific knowledge and understanding.

I would like to extend my best wishes for the successful organization of the conference at Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow. I would also like to applaud the organizers for their hard work and dedication in hosting the conference.

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1946

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November 1, 2019

FORWARD

The prolific efforts and endurance of the Asian Dendrochronological Association has lead to the aspiration of Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, India, to organize the 6th Asian Dendrochronology Conference during November 24-30, 2019. It is a proud privilege for this Institute to formally host the 6th Asian Dendrochronology Conference *"A window to the world of Asian Dendrochronology"* happening for the first time in India. The founder of this Institute Prof. Birbal Sahni envisaged that palaeobotanical research in India coherently adopts the global developments in scientific research in this one of its kind Institute in Asia. With his vision and endurance of the members of the BSIP, Lucknow has developed its abilities to acknowledge the understanding of past scientific research and adopt latest scientific techniques and research methodology. The expertise of our institute is vast ranging and Dendrochronology is one of the significant applications of palaeobotanical research to understand the fluctuations in the climatic conditions on multi-decadal to centennial scales.

The tree-rings record several phenomenons related to climate, stream-flow, glacial fluctuations, fire events, earthquakes, volcanic eruptions etc. The extremities of such past events recorded in this high-resolution proxy can provide important clues of the past occurrences and possibilities of similar future event. The 6th Asian Dendrochronology Conference will create an opportunity for the Asian Dendrochronologists to share and dissipate information about research findings at this global forum under the same roof. I hope this exchange of scientific developments in this conference shall generate greater ideas and deeper understanding among the young minds and expert participants. I look forward to enhancement of the association of our experts at BSIP Lucknow and the participants through this conference and expect finer future relationship among these international participants. I am extremely glad to bring together all these talented researchers at our institute and hope that they witness a fabulous event and extravagances of India and its culture during their stay.

I wish all the participants great success in their entire future endeavor and my heartfelt best wishes to all the staff members and participants for making this conference a grand success.

Vandana Prasad

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November 14, 2019

FROM THE DESK OF THE ORGANIZING SECRETARY

It is my immense pleasure to organize Asian Dendro2019, the 6th Asian Dendrochronology Conference, *"A window to the world of Asian Dendrochronology"* at the Birbal Sahni Institute of Palaeosciences, Lucknow during November 24-30, 2019. It is our proud privilege to inform that for the first time the Asian Dendro conference is being organized in India under the banner of the Asian Dendrochronological Association (ADA). The ADA began this journey of AsianDendro Conference in the year 2007 at Bangkok, Thailand where it was held for the first time. As the title phrase of our conference states *"A window to the world of Asian Dendrochronology"*, it opened a window of opportunity for Asian Dendrochronologist and worldwide tree-ring researchers working in Asia to formally get together under the same roof time and again. This exchange of scientific information and building up of international relationships among these brilliant Dendrochronologists continued in subsequent AsianDendro Conferences held in Xiang, China (2011), Tehran, Iran (2013), Kathmandu, Nepal (2015), Ulaanbaatar, Mongolia (2017). I was fortunate enough to be a student participant at the first ADA in 2007, and then could never have imagined that one day I shall be given this opportunity to host this conference and welcome my fellow dendrochronologists in BSIP, Lucknow, India. This conference is the outcome of the far-reaching endeavors of the ADA. I was absolutely elated when Prof. Nathsuda Pumijumnong motivated me to bid for the 6th AsianDendro Conference during the 10th World Dendrochronology Conference held in Thimpu, Bhutan in 2018. I thank her and all the Dendro Community members present there, for this wonderful opportunity given to me and Birbal Sahni Institute of Palaeosciences, Lucknow, India for hosting the 6th Asian Dendrochronology Conference. The prompt support and permission given to me by Prof. Sunil Bajpai, former Director, BSIP, Lucknow during this bidding process was the keystone to this magnificent event to be organized in India at our Institute.

I would like to proudly mention here that we received 84 abstracts from our Dendro colleagues from 12 nations adding to the potency of our conference. I am indebted to all these researchers who have given a glimpse of their findings in their abstracts to us and am eager to witness the presentations of some exciting research in the various aspects of Dendrochronology. The participants have judiciously contributed to each and every technical session entitled for this conference program and you can further read the details subsequently in this abstract booklet.

The tree-ring science has developed immensely in the past few decades and the level of tree-ring research has raised manifolds. The application of various techniques and developments of new fields and sub-fields in Dendrochronology is inspiring for us to venture in unknown zones of this science and adapt with newer results each day. Asian countries have come a long way in application of Dendrochronology and number of researchers involved in tree-ring studies. India has also witnessed a commendable growth in the number of scientists and young researchers involved in the field of Dendrochronology. Though we have a long way to go to tap our full potential in comparison

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to the extent of sampling resources and infrastructural facilities available at various research Institutes in India. The Birbal Sahni Institute of Palaeosciences has a well established Dendrochronology Laboratory facility since late 1980's and has produced nine Ph.D.'s and few are ongoing. I strongly hope that AsianDendro 2019 Conference will provide us an opportunity to further develop our association with international researchers and create genuine bonds for future research collaborations. My aim to organize this conference was to inspire the young minds with the excellence and perfection of international experts in various aspects of Dendrochronology. The conference also encompasses a two-day training workshops during November 29-30, 2019 in which participants shall be learning Quantitative Wood Anatomy, Tree-ring and R-environment and Dendrogeomorphology by eminent international experts.

The success of every event depends on the financial support provided by the contributors and supporting agencies. I am deeply indebted to various funding agencies, contributors and national and international bodies for partial funding provided for this conference. I would like to thank the Ministry of Earth Sciences, Govt. of India, New Delhi, Indian National Science Academy, New Delhi, Association for Tree-ring Researchers, and many others for the support given to this conference.

As the Organizing Secretary of this conference I convey my heartfelt gratitude to Prof. Ashutosh Sharma, Secretary, DST, Govt. of India and Dr. Dr. Madhavan Nair Rajeevan, Secretary, MOES, Govt. of India, the Patrons of AsianDendro 2019 Conference. I express my sincere thanks to the Chairpersons of AsianDendro 2019 Conference, Prof. Nitin R. Karmalkar, Chairman, Governing Body, BSIP, Prof. L.S. Chamyal, Chairman, Research Advisory Council, BSIP, Dr. Rajiv Kumar Tayal, Secretary, Science & Engineering Research Board (SERB) and Dr. Vandana Prasad, Director, BSIP.

This event has truly reached this stage because of the support of Dr. Vandana Prasad, the Director BSIP who had the vision and wisdom to build the path of the success for AsianDendro2019 conference. I am thankful to the Birbal Sahni Institute of Palaeosciences Lucknow and its competent authorities for supporting Asian Dendrochronological Association to host this event in this grand manner and provide all the necessary help and infrastructure facility. I am also thankful to the members of the Advisory committee and scientific committee of this conference for their constant guidance and kind support. I take this opportunity to thank Mr. Sandeep Kumar Shivhare, Registrar BSIP for his guidance and help given in all administrative formalities. I am deeply indebted to all the staff members and committee members of BSIP, for genuinely helping me and being the most wonderful team working on AsianDendro 2019 conference. I especially thank the BSIP Dendrochronology Laboratory members for standing by me and sincerely supporting me throughout the course of this conference.

I wish everyone all the success for their future and scientific endeavors and welcome all the participants to the 6th Asian Dendrochronological Conference at BSIP Lucknow, India at this great exchange of Dendrochronological Sciences and witness the grandeur of the culture and heritage of India.

Santosh K. Shah

(Santosh Kumar Shah)
Organizing Secretary
&
President, Asian Dendrochronological Association (ADA)

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Mr. Ravi Shankar Maurya
Ms. Sadhana Viswakarma

Sessions & Codes

Session Name	**Code**
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Dendrohydrology: *The extremities of hydroclimatic variations*	**DH**
Tree-rings and Isotopes: *Their amalgamation and linkages*	**IT**
Tropical Dendrochronology: *Where does tree ring studies stand in the tropics?*	**TD**
Wood Anatomy: *The inside story of wood for Dendrochronology*	**WA**
Tree-line Dendrochronology: *Towards the limits of mountain vegetation*	**TL**
Forest and Fire Ecology: *Understanding the forests ecosystem through tree-rings*	**FE**
Dendrochronology in non-traditional species: *Challenges and Opportunities*	**NT**
New methodologies and complication in tree-ring analysis: *Advances and recent developments*	**NM**
Encompassing tree-rings with low-resolution proxies: *A multi-proxy approach*	**MP**
Linking tree-rings with the world oceans: *Tele-connections originating in the blue world*	**TO**
Tree-ring network studies: *Spatio-temporal connections of tree-rings*	**TN**
Environmental pollution & Agriculture Productivity: *Do tree-rings record its signature?*	**EA**
Fossil wood: *Emphasis on tree growth*	**FW**
Oral Presentation	**OR**
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DC – OR01: Climatic records of Monsoon Asia during the past several centuries from tree-rings

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A good quality tree-ring data network has been established from western and central Himalayan region ranging from Kashmir through Uttaranchal and Nepal. Few tree-ring chronologies cover the Medieval Warm Period. Dendroclimatic models based on response function analysis using wide network of tree-ring chronologies and long instrumental records of temperature and precipitation over different parts of Western Himalaya indicate that the summer climate, particularly pre-monsoon temperature and precipitation are highly influencing parameters in tree growth process. This is mainly due to moisture stress condition occurring during the early phase of the growing season of the Himalayan conifers. These response function models have been used to reconstruct summer climate over western Himalaya since past several centuries. These reconstructions indicate overall warming trend in recent decades and also suggest that Little Ice Age phenomenon was not prominent over this part of the globe. Few tree-ring based temperature reconstructions from eastern Himalaya including Sikkim, Bhutan, Arunachal Pradesh show warming in recent decades.

Reconstruction of monsoon variations needs extensive sampling from the central and peninsular India. Some pilot studies have helped in establishing the tropical species (*Tectona grandis*) showing good response to monsoon variations. Initial results of about 200-500 year long tree-ring chronologies of teak (*Tectona grandis*) from central and peninsular part of India show significant correlations with summer monsoon precipitation. It is evident that, two to three consecutive good monsoon years are capable of maintaining normal or above normal tree growth, even though the following year is low precipitation year. Using three different proxies of monsoon rainfall for duration of over 500 years, it was observed that the Asian monsoon has a multi-decadal oscillation with period between 50 years and 80 years that change in time in episodic manner. It was revealed that AMO, El Niño Southern Oscillation (ENSO) as well as the Pacific Decadal Oscillation (PDO) also have such a 50-80 year multi-decadal variability. Coherence between Asian monsoon multi-decadal mode and that of AMO, ENSO and PDO shows that they all are likely to be integral part of a global multi-decadal mode with periodicity of 50-80 years. We speculate that such a multi-decadal mode of variability may arise from ocean-atmosphere-land interactions. Thus, the tree-ring studies in India reveal that the tree-ring chronologies from tropical and extra-tropical regions may be useful to understand the variability of monsoonal climate particularly the low-frequency signals with available data on century scale.

DC – OR02: Log coffin culture uncover Environmental conditions change in northern Thailand

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Archaeological sites in the highlands of northern Thailand reveal about the settlement of wooden coffins. This culture has disappeared from the country, but the evidence remains, especially the large wooden coffins placed in limestone caves. However, the appearance and disappearance of the wooden coffin remains controversial. This research will utilize wood samples from the wooden coffin to investigate the changing environment during the coffin culture and will try to answer the question of whether this culture began and ended about a period of time as well as expertise in the use of local natural resources in the period.

DC – OR03: Tree growth and climate sensitivity of coniferous species in the Hengduan Mountains, SW China

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The Hengduan Mountains in SW China is a topography complex region, and the spatial patterns of tree growth and climate sensitivity of coniferous tree species in this region is relevant for. We compiled 125 tree ring-width (TRW) site chronologies of various coniferous tree species in the Hengduan Mountains, SW China. The latitude and longitude sampling sites range from latitude 25°N to 33°N and from 93°E to 104°E, respectively, while the elevation ranges from 1345 m to 4462 m a.s.l. We calculated ring-width index by using traditional negative and cubic spline detrending methods. We correlated correlation coefficients between site TRW chronology and climate data (precipitation, temperature, self-calibrated Palmer drought severity index (scPDSI) retrieved from the CRU gridded data close to the sampling site. The results showed that averaged annual growth rate decreased with elevation increases, with higher variations at lower elevations. The Gleichlaufigkeit value (GLK), an indicator of agreement among trees, slightly increased with elevation increases. Radial growth of coniferous tree species at high elevations correlated positively with winter and summer temperatures, with higher sensitivity to temperature variations at higher elevations. Radial growth of coniferous tree species at middle and low elevations are sensitive to moisture availability, as indicated by positive correlations with precipitation and scPDSI. We applied the generalized additive mixed model (GAMM) to remove age and size related variations of basal area increment, and the calculated the residuals for long-term trends detection. Accelerated growth rates were found for high elevations sites, probably due to positive effects of regional warming and CO_2 fertilization. However, stable or decline growth trends also detected in lower latitudes and elevations, probably due to combined effects of warming and region drying climate.

DC – OR04: Drought variability over the past two centuries inferred from teak tree rings in southern Myanmar

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Understanding long-term drought variability in Asian tropics is of crucial importance because of its adverse impacts on human populations and ecosystems. By combining three site chronologies, we developed a regional composite ring-width chronology of *Tectona grandis* (teak) from southern Myanmar. Radial growth of teak is negatively related to temperature variations but positively related to precipitation and the self-calibrated Palmer drought severity index (scPDSI) with the highest correlation during the dry season (November–April) ($r = 0.682$, $p < 0.000$). Thus, we reconstructed dry-season drought variability for the period 1802–2016, which explained 46.5% variance of the actual scPDSI during the calibration period. We found that southern Myanmar was under slightly dry conditions, with below-normal scPDSI values along with the intensification of drought in recent years. One extreme drought (1812) and six severe drought years (1810, 1811, 1816, 1852, 1887, and 1980) were observed. Seven major famines (1837–1838, 1860–1861, 1865–1867, 1868–1870, 1873–1874, 1896–1897, and 1943–1944) that occurred in India during 1802–2016 were linked to the drought periods in this study. Our reconstruction showed mild drought conditions during the late Victorian Great Drought (1876–1878) and the El Niño event (1918–1919) periods. Power spectrum analysis detected high- to low-frequency cycles (2.2, 2.6–2.7, and 22.2–39.2 years) likely related to El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) activities. Spatial correlation analyses revealed that drought variability might have a linkage with a broader scale circulation system and the positive phase of ENSO. Our results provide a better understanding of the regional drought variability and are also useful to develop long-term management plans and adaptation measures on drought impacts in the vulnerable areas of Myanmar.

DC – OR05: Temperature variations in subtropical China during the past 200 years

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Tree ring plays an important role in deciphering the paleoclimatic signals over the past 100-1000 years. However, tree-ring studies from tropical to subtropical regions are rarer than that from extra-tropical regions, which greatly limit our understanding of some critical climate change issues. Based on tree-ring-width chronologies in different area of Subtropical China (SC), seasonal temperature histories of different season over the past 200 years were reconstructed. In addition to the warm and cold fluctuations in the reconstructed temperature series, the main conclusions are drawn in the following two aspects: (1) it indicated that the winter-half year temperature had good agreement with summer-time temperature variation in SC at decadal scale, while the winter-half year warming in recent decades was more evident than summer-time, and (2) comparison of the tree-ring based temperature series indicated that the start time of the recent warming in eastern China was regional different. It delayed gradually from north to south, starting at least around 1940 AD in the north part, around 1970 AD in the central part and around 1980s in the south part.

DC – OR06: A 1556-year long early summer moisture reconstruction for the Hexi Corridor, Northwestern China

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We report a 1556 year-long tree-ring width chronology for the Hexi Corridor, in the arid northwestern China, established by applying the signal-free regional curve standardization method to 416 juniper ring-width series. We found that drought in early summer (May–June) is the primary controlling factor for tree growth in this area. We then developed an early summer moisture (i.e., scPDSI) reconstruction from 455 CE to present. Our reconstruction captures multi-centennial scale moisture variations, showing two long-term dry periods during 800–950 CE and 1000–1200 CE, and two long-term wet periods during 1200–1450 CE and 1510–1620 CE. We found strong similarities between hydroclimatic changes in the Hexi Corridor and Qaidam Basin from interannual to centennial timescales; however, at multi-centennial (> 300 years) timescales, hydroclimatic variations in the two regions showed significant regional differences. The Hexi Corridor witnessed a generally dry Medieval Climate Anomaly (MCA, here 800–1100 CE), and drying 20th century, whereas the Qaidam Basin experienced high-precipitation periods during the MCA and 20th century. The different correlations with Northern Hemisphere temperature suggest that the Qaidam Basin will receive more precipitation under global warming, whereas the Hexi Corridor will become dryer in the future.

DC – OR07: Growth-climate response of *Abies spectabilis* in Manaslu Conservation Area, central Himalaya, Nepal

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Central Himalaya is experiencing rapid climate change along with its diverse impacts on biophysical environment. An understanding of growth-climate responses of tree species across their distribution range is essential to devise forest management and conservation strategies to cope with adverse impacts of climate change. This study was carried out in Manaslu Conservation Area, Nepal with an aim to know how radial growth of Himalayan fir (*Abies spectabilis* D. Don) varies with elevation and which climatic factors are mainly limiting the radial growth along the elevation gradient? Tree ring-width chronologies of Himalayan fir were developed from three elevational bands: at the upper distribution limit (3750-3900 m), in the middle range (3500-3600 m) and at the lower distribution limit (3200-3300 m), and their relations with climatic factors were analyzed. Tree growth of Himalayan fir varied synchronously across elevational bands, with recent growth increases observed at all elevations. Growth-climate response analysis revealed that trees growing at two high elevation sites showed a stronger response to winter temperatures compared to lower sites. Radial growth of Himalayan fir across the elevation gradient correlated positively (negatively) with temperature (precipitation and SPEI-03) during the summer season. Moving correlation analysis revealed a persistent response of tree growth to summer temperatures (May, August); however, growth response to spring moisture availability is increasing in recent decades. Under sufficient moisture availability, increasing summer temperature might be beneficial for fir trees growing at all elevations while trees growing at the treeline can take additional benefit in the growth from winter warming.

DC – OR08: *Picea obovata* has divergent growth trends and climatic response on individual scale along full-range elevational gradient in Western Sayan Mountains, Siberia

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In mountain ecosystems, plants are sensitive to climate changes, and an entire range of species distribution can be observed in a small area. Therefore, mountains are of great interest for climate–growth relationship analysis. In this study, the Siberian spruce's (*Picea obovata* Ledeb.) radial growth and its climatic response were investigated in the Western Sayan Mountains, near the Sayano-Shushenskoe Reservoir. Sampling was performed at three sites along an elevational gradient: at the lower border of the species range, in the middle, and at the tree line. Divergence of growth trends between individual trees was observed at each site, with micro-site landscape-soil conditions as the most probable driver of this phenomenon. Cluster analysis of individual tree-ring width series based on inter-serial correlation was carried out, resulting in two sub-set chronologies being developed for each site. These chronologies appear to have substantial differences in their climatic responses, mainly during the cold season. This response was not constant due to regional climatic change and the local influence of the nearby Sayano-Shushenskoe Reservoir. The main response of spruce to growing season conditions has a typical elevational pattern expected in mountains: impact of temperature shifts with elevation from positive to negative, and impact of precipitation shifts in the opposite direction. Chronologies of trees, growing under more severe micro-conditions, are very sensitive to temperature during September–April and to precipitation during October–December, and they record both inter-annual and long-term climatic variation. Consequently, it would be interesting to test if they indicate the Siberian High anticyclone, which is the main driver of these climatic factors.

DC – OR09: Tree ring-width records from north Sikkim of India and its association with moisture and heat index: A case study

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A tree-ring data of *Tsuga dumosa* of 438 years (1572-2009 C.E.) from the north Sikkim of India have been carried out in relation to climate fluctuations over the region. The relationship shows that late summer (July to September) heat index and temperature of the region have negative impact on tree growth while moisture index exhibits a positive relationship with tree growth during late spring (April to May). Heat index and mean temperature showed constantly significant correlation coefficients, suggesting that the late summer heat index might be the important climatic parameters influencing the tree growth patterns over the region. The results indicate that the rising heat index/temperature during late summer might enhance the moisture deficiency over the region by accelerating potential evapotranspiration, which is not found to be conducive for tree growth.

DC – OR10: Winter temperature variations in the central Himalaya, Nepal

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To better understand the historic winter temperature variation in the central Himalaya, we developed a new tree-ring width chronology (span: 1787-2013, 227 years) of shrub rhododendron (*Rhododendron campanulatum* D. Don) at Krumholtz treeline (Mt. Gaurishankar, Rolwaling Himal). Simple and seasonal correlation analysis showed positive relationship of tree radial growth with winter and summer temperature. Furthermore, correlation coefficient was highest with the late winter (January-February) minimum temperature and the temperature sensitivity was consistent over time (1950-2013) indicating the radial growth response of *R. campanulatum* is strongly limited by late winter minimum temperature. Based on the calibration-verification statistics (during 1950-2013), we reconstructed the winter minimum temperature variations. Reconstructed temperature showed tele-connection with large scale climatic drivers related to sea surface temperature (SST) variations in tropical Pacific Ocean. Warm-cool episodes in the central Himalaya coincide with other regional temperature records from the Himalayas, Tibetan Plateau and vicinities in the northern Hemisphere. Our reconstruction revealed continuous warming trend (since 1970s) persistent to modern period that coincides with continental-scale warming.

DC – OR11: Tree ring based Pre monsoon precipitation reconstruction and its linkage with large tropical volcanic eruptions and severe droughts in the central Himalayas

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Himalayan birch (*Betula utilis* D. Don) is a long-lived, broadleaf tree species native to the Himalayas. However, it has received limited attention for dendroclimatological studies in comparison to *Pinus*, *Picea*, *Larix*, *Juniperus*, *Quercus*, or *Fagus*. In the Himalayas, Himalayan birch (*Betula utilis*) is a widespread broadleaf timberline species that survives in mountain rain shadows via access to water from snowmelt. Because precipitation in the Nepalese Himalayas decreases with increasing elevation, we hypothesized that the growth of birch at the upper timberlines between 3900 and 4150 m above sea level is primarily limited by moisture availability rather than by low temperature. To examine this assumption, a total of 292 increment cores from 211 birch trees at nine timberline sites were taken for dendroecological analysis. The synchronous occurrence of narrow rings and the high inter series correlations within and among sites evidenced a reliable cross-dating and a common climatic signal in the tree-ring width variations. From March to May, all nine tree ring-width site chronologies showed a strong positive response to total precipitation and a less-strong negative response to temperature. During the instrumental meteorological record (from 1960 to the present), years with a high percentage of locally missing rings coincided with dry and warm pre-monsoon seasons. Moreover, periods of below-average growth are in phase with well-known drought events all over monsoon Asia, showing additional evidence that Himalayan birch growth at the upper timberlines is persistently limited by moisture availability. Our study describes the rare case of a drought-induced alpine timberline that is comprised of a broadleaf tree species.

In addition, using a tree-ring network of precisely dated Himalayan birch in the central Himalayas, we reconstructed variations in the regional pre-monsoon precipitation back to 1650 CE. A superposed epoch analysis indicates that the pre-monsoon regional droughts are associated with large tropical volcanic eruptions, appearing to have a strong influence on hydroclimatic conditions in the central Himalayas. In fact, the most severe drought since 1650 CE occurred after the Tambora eruption. These results suggest that dry conditions prior to monsoon in the central Himalayas were associated with explosive tropical volcanism. Prolonged La Niña events also correspond with persistent pre-monsoon droughts in the central Himalayas. Our results provide evidence that large tropical volcanic eruptions most likely induced severe droughts prior to monsoon in the central Himalayas.

DC – OR12: Climate-growth relationships of tree species in extreme arid mountain and their potential for climate research

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Dendrochronology is a powerful tool to develop high resolution and exactly dated proxies for climatic research. However, most extreme drought regions are facing challenge of generating biologically long-term climate records due to the increased difficulty of sample collection and crossdating caused by numerous narrow/ absent rings. A large number of living and dead trees collected from the extreme arid forest border have been used to develop an exactly dated annual ring-width chronology (NMH_{STD}) using accurately crossdating techniques for the Buerhanbuda Mts. near Nuomuhong Village. This is by far the longest ring-width chronology in the southeastern Qaidam Basin (QB). In this study, we discuss the possibilities and methods of establishing a reliable tree-ring width chronology in the extreme arid environment. In addition, we investigated the relationship between different local climate data (from different meteorological stations or gridded dataset) and the NMH_{STD} chronology by simple regression analyses. The results suggest that the relationships between climate factors and NMH_{STD} chronology have statistical characteristics that the moisture regime during the months at the onset of the growing season is the primary control on tree growth. The chronology is moisture-sensitive and suitable for reconstruction of the drought history and the related climate forcing over the past three millennia in the study region.

DC – OR13: Climate Sensitivity Pine Forests (*Pinus roxburghii, Pinus wallichiana*) in the Mid Hills of Central Himalaya

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Pine forests have been key component of vegetation belt across the lower elevations of the great Himalaya range for almost its entire length of 3000 km. Pine forests are found in Pakistan's Punjab Province in the west through Kashmir, the northern Indian states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Sikkim, Nepal and Bhutan, which is the eastern extent of the pine forest, and also extending further east up to north west Yunnan of China. There has also been a massive plantation of Pine due to its high economic values although the long term ecological consequences of Pine forests are less explored in terms of its impact on water use efficiency and its role on regulating ecosystem processes. We have extracted tree cores of two dominant Pine species (*Pinus roxburghii, Pinus wallichiana*) from mid hills of central Nepal from planted (*Pinus roxburghii*), and natural (*Pinus wallichiana*) populations and analyzed the growth-climate relationships of these species with the climatic data from the nearest meteorological stations, and also examined the temporal patterns of BAI (aboveground biomass production) in both forests. Our results indicated that chir pine (*Pinus roxburghii*) did not show any growth limiting climatic factors from the lower elevation, however blue pine (*Pinus wallichiana*) from relatively higher elevation showed positive correlation with total rainfall of January and March, and with minimum temperature (Tmin) of previous year's September showing that the more moisture in very early growing season contributes positively to radial growth. Further BAI trend showed that both forests were relatively healthy showing the normal sigmoid temporal patterns. However, unusual sharp decline on BAI was found to be associated with resin extraction in case of planted chir pine forests, that perfectly matched with the year and after of resin extraction, Blue pine from higher elevation showed normal BAI trend with some marked growth decline in recent decades (2000, 2012-2014), and the cause of decline is yet to be confirmed whether it is due to climate or anthropogenic causes. We infer that Pine forests of mid-hills of central Nepal are sub-healthy mainly by anthropogenic causes associated with forest management practices, and the growth performance of these forest may decline in cases of intensified spring drought (early growing season) in the region. However, the studies with wider spatiotemporal scales would be ideally important to improve our understanding on growth performance of these species in central Himalaya.

DC – OR14: An appraisal of tree-ring based temperature records from the Himalayan region

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Tree-ring chronologies have been extensively used to develop temperature reconstructions using conifer species growing in different parts of the Himalaya. The reconstructions are based on the existence of both positive and negative relationship between the tree-ring chronologies and instrumental temperature records. From the published records, it is noted that temperature reconstructions based on the existence of positive relationship between tree- ring and temperature series are very few. Regional temperature reconstructions developed using network of tree-ring series have revealed significant correlation with the regional data. On critical assessment of the available tree-ring-based temperature reconstructions glaring anomalies were reported especially in case of the extreme years coinciding with the volcanic eruption associated cooling. Tree-ring-based reconstructions from Kashmir and Nepal, where temperature has direct forcing on tree-ring widths, indicated unusually cold temperatures in 1816, coinciding with the Tambora volcanic eruption in April 1815 in Indonesia. However, in the case of the chronologies having negative relationship with temperature, usually warmer conditions are reconstructed against the narrow rings usually observed in 1816. The narrow rings in 1816 could have been caused due to volcanic eruption induced cooling as well as reduced solar radiation restricting photosynthesis. Thus, changes in the limiting factor could have led to the breakdown of relationship between tree-ring indices and climate parameters. In view of this, it is suggested that the environmental variables having direct relationship with tree growth should be reconstructed from tree-ring chronologies as there exists fair possibility that the growth limiting factor such as temperature remains stable over time.

DC – OR15: Tree ring data of *Pinus wallichiana* a good proxy of summer drought reconstruction during the past three centuries from Darma, Valley, North Western Himalaya

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Paleoclimatic proxies, such as tree-rings, widely analyse to extend the meteorological records back for centuries that could be used for the better understanding of hydroclimatic variables to make realistic predictive climate model. In this pursuit, we develop a well-replicated tree-ring width chronology of *Pinus wallichiana* that extends back to 1746-2017C.E, form Darma, Valley, North Western Himalaya. In the tree growth climate analysis, we recorded a significantly strong positive correlation (n = 116, r = +0.601, p<0.001) between summer (June-September) Standardized Precipitation Evapotranspiration Index (SPEI). The SPEI is based on precipitation and temperature data, and it has the advantage of combining multiscalar character with the capacity to include the effects of temperature variability on drought assessment. Based on these relationships, summer SPEI reconstructed since 1746-2017 C.E. for this region. The variance explained during calibration (1903-2017 C.E.) period is 36.8%. The reconstructed summer SPEI can represent large-scale June-September SPEI variations over the Himalayan region. The extended SPEI time series has revealed several intervals of high and low intensity drought. This study could be useful for the management of crop failure and sustainable use of water resources, especially in the monsoon months.

DC – OR16: Inferring the glacier behavior since Little Ice Age (LIA) using tree rings in the Chandra-Bhaga basin, northwestern Himalaya

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The Little Ice Age (LIA), ca. CE 1250–1850, was a cold period of global extent, with varying intensity and timing of reduced temperatures across regions. In recent years, dendrochronological dating have been explored to provide the nature of glacier behaviour during the LIA and post-LIA mainly across the Tibetan region but the adjacent region in the southern part of the Himalaya is comparatively less explored. Additionally, studies pertaining to the nature of long term glacier fluctuations since LIA and particularly deglaciation following the LIA maxima are virtually non-existent for the Himalayan region. Such gaps have been tried to be filled-up by a multi-data integrated approach (MDIA) that mainly includes tree rings, remote sensing, and historical records with the supplement of field based geomorphological mapping in the Chandra-Bhaga valley of North-western Himalaya. The analyses are under way and the overall response of climatic and non-climatic factors on the long-term glacier behaviour since LIA across this region will be addressed.

DC – OR17: Gangotri glacier terminus dynamics in last 447 years: inferred from tree-rings

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Glaciers, the natural reserves of fresh water controlling hydrology of any region, are under threat with increase in earth's temperature. The glaciers of the Himalayan region, feeding several major rivers in north India, have experienced drastic retreat in the recent decades. Since glacier terminus behaviour is coupled with climate, it warrants thorough investigation for better management and planning of water resources under the backdrop of climate change. However, due to difficult approach and harsh climatic conditions only few Himalayan glaciers in India are under continuous monitoring since past few decades. The most well documented glacier in terms of terminus measurement, the Gangotri, is source of the Bhagirathi River, the largest river system in India. However, its precise dynamics in the past few centuries is not well constrained. Here, study of climatically sensitive sub-alpine trees and shrubs growing in glaciers forefield were used to understand the Gangotri glacier terminus dynamics. We developed *Betula utilis* and *Pinus wallichiana* ring-width chronologies from their respective upper most forest limits, which revealed role of temperature modulating trees growth pattern. *Pinus wallichiana* ring-width chronology also revealed coherence with temperature proxies, showing regional and hemispheric scale temperature signal. Tree-ring chronologies developed also revealed expansion/retreat of Gangotri glacier during cool/warm phases. The colonization pattern of trees in the glacier forefield revealed that in past 447 years Gangotri glacier terminus receded at unprecedented rapid rate since 1950s with the onset of the 20th century warming.

DC – OR18: Centennial scale summer climate reconstruction using tree-ring records from the north Kashmir, India

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Knowledge of climate and climate variability over the Himalayan region is important under the changing climate, as millions of people are dependent on the rivers originated from the Himalayan glaciers. Tree-rings are known as excellent proxies for understanding of centennial scale climatic variations before instrumental era and to assess the effects of the recent global climate change. Tree ring based studies from Jammu & Kashmir region of the Himalaya are scant. Here we present, results obtained from >100 tree core samples of *Cedrus deodara* and *Abies pindrow* from four different forest sites (Dangiari, Kaleban, Kanzalwan and Mawar) of north Kashmir. The statistical calculations for all the four chronologies have given good results. Moderately high values of SNR, EPS and mean sensitivity suggest good potential of all the four sites for dendroclimatic studies. The tree-ring chronology from Dangiari spans around 400 years. The tree-ring index chronologies from Kaleban, Kanzalwan and Mawar sites span 210-325 years. Meteorological data of the Srinagar station, which is comparatively closer to the tree-ring sites, have been used in response function analyses to understand the tree growth-climate relationship. The analyses clearly indicate response of summer temperature and precipitation over the tree growth. Thus, the summer climatic parameters could be reconstructed with statistical significance. Results from the analyses and reconstructed series would be presented in the conference.

DC – OR19: Tree-ring deduced drought records from Lahaul-Spiti, western Himalaya, India

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Lahaul-Spiti is semi-arid to arid cold desert region situated in the northern part of Himachal Pradesh. In the Lahaul-Spiti major part of the annual precipitation occurs due to the westerlies (winter monsoon) from December-April. Due to its orography and topographic barriers of the Pir-Panjal range, summer monsoon does not reach properly and only drizzling occurs during summers. Thus, the winter monsoon failure causes drought conditions over the studied region. So, tree-ring samples of Himalayan cedar (*Cedrus deodara*) and Himalayan pine (*Pinus wallichiana*) were collected from steep slope sites in Lahaul-Spiti, Himachal Pradesh. All the samples are analyzed together and found sensitive to precipitation Using annually resolved well-replicated tree-ring data of Himalayan cedar and Himalayan pine, robust 11-month Standardized Precipitation Index of July (SPI11-July) extending back to AD 1437 was developed. The most peculiar feature of the reconstruction is prolonged drought phase during the Little Ice Age (LIA) and 1626 being the driest year followed by 1554, 1705, 1971, 2008 and 1785. In the reconstruction pluvial phases were noticed in the later part of the 20th century. Drought and pluvial phases in the reconstructed series are comparable with other hydrological reconstructions present from the semi-arid western Himalayan region, influenced by westerlies. Such drought reconstruction from the data-scarce region is very significant for the agrarian economy in long-term perspective.

DC – OR20: Reconstructions of hydro-meteorological and glacial fluctuations from the Himalaya based on Dendrochronology

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Analyses of dated tree ring series (Dendrochronology) are a suitable tool to study and document changes in past climate, stream flow, glacial fluctuations, etc. The relationship between instrumentally measured hydro-meteorological records with the corresponding year's growth of climatically sensitive trees provides a basis for the extension of these records. We reconstructed winter drought since 1767 C.E., from Uttarkashi Garhwal Himalaya, which would be of great significance for the management of rabi crops at this region. Based on the relationship of multi-species tree-ring data and glaciers mass balance, we extended the mass balance record back to 1615 C.E., for the Western Himalayan glaciers, which is the longest reconstructed data from the Himalaya. This study reveals that the later phase of Little Ice Age (LIA) was substantially briefer and weaker in the Himalaya in comparison to other regions of the Northern Hemisphere. Tree ring data is also found suitable for the river discharge reconstruction from the Himalaya region. Tree ring data of *Cedrus deodara* from Beas river basin, Western Himalaya extend discharge data back to 1834 C.E., whereas tree-ring records of *Abies densa* is used to extend the discharge of the Zemu river – a first stage of Teesta River, North Sikkim Eastern Himalaya back to 1775 C.E. The long generated hydrometeorological and glacial data can serve as a source of reliable data to the scientific community and planner for the management, development, mitigation, and adaptation plan.

DC – OR21: Precipitation reconstruction of Srinagar from tree rings of *Abies pindrow*

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Climate change has significant impacts on ecosystem dynamics and social communities. High mountains around the globe are some of the most vulnerable regions to climate change. To understand the climatic fluctuations at a regional scale, we need to have longer past climatic data. The problem at most of the remote mountainous areas is the lack of long instrumental climatic data. Trees record the environmental information in their annual growth rings. The main advantage with the climatic data reconstructed from tree rings is that it is annually resolved and well calibrated and verified. The objective of this study was to develop precipitation reconstruction from climatically sensitive trees and to compare that with the previous reconstructions and historical climate records. Trees growing at lower altitudinal limits of their distribution range showed significant positive response to growing season April-August total precipitation. Therefore, April-August total precipitation at Srinagar was reconstructed back to 1705. 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 reconstructed precipitation was able to capture some of the historically known climatic events. Most of the historically documented drought and flood years that occurred in Kashmir were captured by this reconstruction. Further, most of the wet and dry years captured in this reconstruction resembled earlier reconstructions. This reconstruction added 196 years to the instrumental climate data of Srinagar, Jammu and Kashmir, India. This study will help in understanding the variation in precipitation at long-term scale and highlights the importance of Himalayan conifers in recording the variability in climatic factors.

DC – OR22: Spatio-temporal summer temperature variability in Kashmir valley, Northwest Himalaya since 1701 C.E.

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The reconstruction of spatio-temporal temperature variability has been made using tree–rings of Deodar (*Cedrus deodara*) from Kashmir valley, NW Himalaya. The three tree-ring chronologies developed from the region showed significant negative relationship with Summer (May-August) temperatures. Based on this relationship, we reconstructed spatiotemporal summer temperature since 1701 C.E. using ensemble point–by–point principal component regression approach. The reconstructed temperature has been assessed for long-term cold and warm periods. The long-term warm periods (1823-1887, 1909-1948 C.E.) and cold periods (1807-1822 and 1888-1908 C.E.) are noted in reconstructed summer temperature averaged over Kashmir valley. The lowering of the temperature recorded during 1810 to 1819 C.E. might be due to the effects of volcanic eruptions.

DC – PO01: A multi-parameter tree-ring response analysis of *Pinus kesiya* from Manipur, Northeast India with daily climate data

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Chronologies of earlywood (EW), latewood (LW), adjusted latewood (adjLW) and total ring width (TRW) were developed from tree-rings of Khasi pine (*Pinus kesiya*) collected from Manipur, northeast India, covering a 39 year period (1980-2018 C.E.). The main aim of this study was to evaluate the potential of TRW, EW, LW and adjLW of *P. kesiya* in dendrochronological studies using gridded daily climate data (meant temperature and rainfall). The response of daily mean temperature on TRW and EW is significant and inverse during March 24 to May 27 and positive with rainfall February 24 to March 25. For LW, the mean temperature from April 5 to May 4 had significant negative relationship, while it showed a positive response to rainfall during September 12 to October 14. The adjLW exhibited significant inverse relationship with August 31 to October 20 mean temperature, and a significant positive relationship with rainfall during September 12 to October 13. Based on these results, there exists the potential to develop pre-monsoon and late-summer weather conditions from EW and adjLW respectively. The predominance of low rainfall and high temperature during the significantly correlated months (March to May) suggest soil moisture condition during pre-monsoon season is limiting for the growth of Khasi pine. Spatial correlation analysis reveals strong relationship of tree growth with sea surface temperature (SST) of the Indian and Equatorial Pacific Ocean during winter and pre-monsoon months. In addition, the formation of Intra-annual density fluctuations (IADF) was also examined and a link with precipitation variations during the growing season was observed. A higher number of samples of *P. kesiya* should be collected from this region in order to enhance the chronology statistics and to extend the length of the chronology.

DC – PO02: Four tree species under climate change in moisture-limited area of South Siberia, Russia

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The response of vegetation to climate change is of special interest in regions where rapid warming is coupled with moisture deficit. This raises the question of the limits in plants' acclimation ability and consequent shifts of the vegetation cover. Radial growth dynamics and climatic response were investigated for *Pinus sylvestris* L., *Larix sibirica* Ledeb., and *Betula pendula* Roth. in the forest-steppe and for *Ulmus pumila* L. in the steppe of South Siberia as indicators of vegetation state and dynamics. Climate–growth relationships were analyzed by two approaches: 1) correlations between tree-ring width chronologies and short-term moving climatic series; 2) optimization of the parameters of the Vaganov-Shashkin tree growth simulation model to assess ecophysiological characteristics of species. Regional warming was accompanied with a slower increase of average moisture deficit, but not severity of droughts. In the forest-steppe, trees display a stable growth and respond to the May-July climate, but there was evidence of reversible drought-induced deforestation in the past. In the steppe, elm is limited by moisture deficit in May–beginning of June, during peak water deficit. Forest-steppe stands are apparently acclimated successfully to the current climatic trends; heterogeneous landscape of foothills provides opportunity of natural forest regeneration after drought-induced deforestations. It seems that different biophysical mechanisms used by elm to counter water deficit (transpiration regulated by stomata morphology and xylem structure, using most of stem as water reservoir, earlier onset and high rates of growth) give this species advantages leading to it expansion in steppes.

DC – PO03: Response of climate on the radial growth of *Pinus kesiya* Royle ex. Gordon in Shillong, Meghalaya, India

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Pinus kesiya Royle ex. Gordon is an endemic flora of Meghalaya, it is a tropical pine growing in eastern Himalaya and grows widely in the Khasi Hills either in pure stands or nearly pure stands. This study was conducted to update the earlier developed tree-ring chronology and to determine the response of various climatic factor and drought on growth of *P. kesiya* in Shillong, Meghalaya, northeastern India. Tree cores were collected from three Protected Forest and two-reserved Forest in and around Shillong. A total of 109 core samples were used for analysis and the series inter-correlation was 0.367. The updated time period in the tree-ring chronology of *P. kesiya* from Shillong was from 2000-2018 and the response of climate on growth of *P. kesiya* was shown through Pearson correlation. The correlation is significantly negative with minimum temperature for current year month of May and June, mean temperature and maximum temperature for current year month of April and May. The correlation with rainfall showed a significant positive relationship with the previous year November, December and current year month of February, March and May. This positive relationship with rainfall showed that growth of *P. kesiya* in this region depends on rainfall. Correlation with drought index showed a positive significant relationship with the current year month, PDSI February to June, scPDSI April, May and June. The positive response with drought index indicated that there was a hydrological drought in Shillong during the pre-monsoon period.

DC – PO04: Tree-ring recorded synchronous drought regime in north-central China during the last century

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Drought is the most devastating natural disaster that affects people's livelihood in ecologically fragile regions. In the context of global warming, it is projected that the aridity in the arid and semi-arid regions is increasing. In terms of the condition, understanding the drought history is of importance. Here we reported a new ring-width chronology of Chinese pine (*Pinus tabulaefomis*) in Helan Mountains, north-central China. Response function analysis revealed that the chronology correlated significantly with annual (prior July to current June) precipitation ($r= 0.64$, $p<0.01$). And we reconstructed the Helan precipitation from A.D. 1875 to 2018. Considering the geographical settings of the Helan Mountains, which surrounded by the desert lands, including the Tengger Desert in the west and the Ortintag Sand Land in the northeast, we investigated the historical climate variability between the mountainous and the desert regions. In conjunction with four tree-ring based Palm Drought Severity Index reconstructions nearby, commonly temporal and spatial drought variability were revealed. Three of the four series were from the South Tengger Desert margins (the Changlin Mountains, the Luo Mountains, and the Hasi Mountains), while the rest was in the edge of the Ortintag Sand Land. It was found that the Helan precipitation reconstruction agreed well with the four drought series from the desert marginal area, and captured the severe drought events, which occurred in the 1920s~1930s, and 1960s, respectively. The temporal synchronization demonstrated that tree rings were capable of illustrating climate variability in the desert area. Additionally, it was inferred that the apparent drought events in the 1920s~1930s and the 1960s, coincidently identified across the north-central China, were attributed to increasing evapotranspiration deduced by warming trend. The comparison between our Helan reconstruction and the desert marginal drought series will shed light on the feasibility of tree rings as a powerful proxy in desert area.

DC – PO05: Tree ring signatures of drought variability in Uttarakhand, western Himalaya, India

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Drought variability in the Himalayan region in the long-term context is not well understood due to the paucity of weather records limited to the past century. Only few weather station instrumental data span over the past century. In such situations, high-resolution tree-ring records from moisture stressed regions provide the alternative tool to extend drought variability records back to past several centuries. The tree-ring data from various regions in the western Himalaya have proven to be very useful to develop long-term reconstruction of drought indices such as standardized precipitation index (SPI) and standardized precipitation evapotranspiration index (SPEI). Here we present SPI7-May and SPEI4-May reconstructions developed using tree ring data of Himalayan cedar from the Kumaun and Garhwal Himalaya respectively. SPI7-May reconstruction (AD 1720-2012) revealed high year-to-year variability. The multi-year droughts occurred in 1920-1924, 1782-1786, 1812-1816, 1744-1748, 1964-1968 and pluvial in 1911-1915, 1723-1727 and 1733-1737, respectively. Similarly, the SPEI4-May reconstruction (AD 1773-2016) also showed high year-to-year variability. The most revealing multi-year droughts revealed in SPEI4-May reconstruction occurred in 1819-1823, 1816-1820, 1800-1804, 1774-1778 and 1890-1894, respectively. In both (SPI7-May & SPEI4-May) reconstructions 1920s and 1970s were very dry and showed drying tendency in recent decades. The study revealed that the tree-ring records from moisture stressed sites from the Kumaun and Garhwal Himalaya should be very useful to develop long-term drought records for the region.

DC – PO06: 160 years of warm-season temperature variability in Subtropics China inferred from tree-ring blue intensity

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Blue Intensity (BI) has been utilized primarily as an indirect proxy measurement from high latitude, temperature-limited boreal forests. It is obviously that more BI data obtained from different regions, especially in the middle and low latitudes with different climatic conditions could contribute to our understanding of the method's advantages and weaknesses. We developed 160-year BI measurements from the cross dated ring series of Chinese red pine (*Pinus massiniana*) from the Fang Guangyan Provincial Cultural Relics Protection Area (FGY), subtropical China. The correlation of our BI measurements with climate, strongest for ΔBI (LWBI-EWBI), with a best-fit target season in warm-season (AMJJA) ($r = -0.72$, $n = 62$, $p < 0.001$), and we reconstructed the first previous warm-season temperature since 1863 based on tree-ring BI data. Compared with previous studies, the BI of latewood from high latitude, temperature-limited boreal forests is positively correlated with temperature, while low latitude area, reported here, is significantly negatively correlated with temperature, so it is simply considered that the lignification process is not controlled by temperature alone. The response of BI to climate in low latitude areas with drought stress is more complicated than that in high latitude area, and we believe that drought stress caused by high temperature limits the lignification process of cells.

DC – PO07: Tree-ring inferred snowfall variability over Lahaul-Spiti Himachal Pradesh, India

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In the era of global warming, it has been observed that the earth's average temperature is increasing rapidly in the last few decades. The on-going global warming is largely regulating the regional climatic conditions and disturbing the natural climatic equilibrium. The pattern of precipitation, crop ripping and plant/flowers blooming was found changing in recent decades and believed to occur due to the consequences of climate change. The warming of global mean temperature is not only disturbing the climatic parameters but also creating threat for the socio-economic lives. Glaciers are the vital source for the large number of rivers, which originates from the glacial regions and in the recent decades under the influence of global warming glaciers from different part of the earth are showing receding trends. Various studies indicate that following the global trend, Himalayan glaciers (called as the water tower of Asia) also retreating which pose a major concern for policy-makers to manage livelihood. Lahaul-Spiti is a semi-arid cold desert where maximum part of annual precipitation occurs during winter and spring seasons by mid-latitude westerlies and contains the largest glaciated area of western Himalaya. These glaciers are highly dependent on winter and spring precipitation for their feeding and maintaining the hydroclimatic equilibrium of the region. In this view, the present study is an attempt to understand the snowfall variability over Lahaul-Spiti, Himachal Pradesh. So, tree-ring samples of Himalayan cedar were collected from high altitude moisture stressed sites and extended snowfall variability records back to the past seven centuries. In the reconstruction, severe droughts were recorded in late seventeenth and eighteenth century and pluvial in the late twentieth century. Tree-ring based such robust records from the cold desert region would be very helpful to understand the long-term snowfall variability over western Himalaya.

DC – PO08: Tree-ring study of *Pinus wallichiana* from Chumey valley, Bumthang, Bhutan

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Tree-rings are natural proxy recorders and can act as reliable records for historical environmental information. The tree-ring chronologies place the present in proper historical context, enhance our knowledge of current environmental processes and conditions, and also help to improve understanding of possible future environmental issues. This study was aimed to develop chronology of *Pinus wallichiana* from Chumey and to find the response of tree growth to climate and scPDSI. Coring techniques were used to core two samples from each tree that are old. A 304-year long, tree-ring width chronology (spanning 1715–2018 C.E.) was developed for *Pinus wallichiana* A. B. Jacks. (Himalayan Blue pine) from Chumey Valley, Bumthang, eastern Himalaya. The chronology was developed using 52 tree cores from 36 living trees. The chronology was developed using computer program ARSTAN. The study shows a reliable EPS (.945) and high SNR (17.25) indicating that chronology is useful for the determination of past climatic signals and moderate values of mean sensitivity (.171) represented good dendroclimatic potential of the blue pine. Simple Pearson correlation analysis with monthly climate records from CRU data sets showed a significant direct positive relationship of tree growth with winter temperature. Correlation analysis with scPDSI with tree growth also showed a positive relation and continuation of growth of *Pinus wallichiana* withstanding the drought events indicates that the species is resilience to climate change, especially in dry environments.

DC – PO09: Dendroclimatic application of Himalayan cedar tree-rings from Chamba, Himachal Pradesh, Western Himalaya

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Western Himalaya, depending on varying topography from outer Himalaya to inner high Himalayas, ranges from sub-tropical to alpine vegetation. Many of the trees growing in these forests, especially conifers are known to have datable growth rings. The Himalayan cedar (*Cedrus deodara*) commonly known as deodar is distributed in Hindu Kush, Karakoram and western Himalaya. Natural distribution of Himalayan cedar in the western Himalaya is limited to the areas where winter snowfall is the main source of precipitation. Tree ring samples of Himalayan cedar were collected from moisture stressed site in Chamba, Himachal Pradesh, western Himalaya. To minimize the effect of competition and external injuries on tree-growth healthy undisturbed trees were collected from open forest areas. Growth-ring sequences among the tree-ring samples showed very good cross-dating. Using Himalayan cedar tree-ring samples 288 years long ring-width chronology developed to investigate its potential in dendroclimatic studies. Response function analyses using climate data and ring-width chronology showed that the growth of Himalayan cedar is directly related to precipitation from previous years November to current years May, while temperature showed negative relationship with tree-growth. Using such correlation with observed precipitation data from the Chamba Himalayan region long-term precipitation could be reconstructed. The present research could be further improved by adding more predictor chronologies from the region. Robust reconstruction would be very useful in understanding of the precipitation variability in long-term perspective.

DH – OR01: Impact of diverted river flow on the growth of *Pinus roxburghii* in the riparian zone of Western Himalayan River

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The Run of River (ROR) scheme of Hydropower was selected in Nandakini River, Uttarakhand, to estimate the impact of different river flow conditions on the diameter increment of *Pinus roxburghii.* A dendrochronological method was used to measure the tree ring width and increment per year was calculated in five year pre and post diversion period. The sampling was done in different flow conditions viz. Control (Upstream of barrage), Diverted (Between barrage and power house) and altered flow condition (downstream of power house). All the trees were also divided into different age classes (wherever existed). In control conditions, pre and post diversion increment of *Pinus roxburghii* did not show any significant difference in 50-60 and 60-70 age classes. In diverted flow conditions, increment in pre diversion was significantly higher in the 10-20 age class but a non-significant difference was found in 20-30 year age class. In altered condition, pre and post diversion increment of *Pinus roxburghii* did not show any significant difference in age class 10-20. Comparison among different age classes showed that the increment per year deferred non-significantly between age class 10-20 & 20-30. A significant difference (P=0.011) in per year increment was recorded between other age classes. The results showed that the trees of lower age classes were more sensitive to water stress than higher age classes in post diversion period. A non-significant change in increment in altered flow condition explains that the river flow regime becomes more or less similar to the natural flow of the river. So it can be concluded that the ROR projects may have small scale impact but cumulatively these project can have a huge impact on the growth of trees as a larger portion of riparian areas face water stress.

DH – OR02: Reconstruction of hydrological changes of Rambiara river of Pir Panjal range from North West Himalaya based on tree-ring data of *Picea smithiana*

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The Rambiara River Basin covers around 660 km^2 area of the Pir Panjal Range, northwest Himalaya. To understand the hydroclimatic variability and river dynamics of the basin, long term river discharge data is required. The reconstruction of dendro-hydrological data is very useful for analyzing the river discharge in long term perspective. With this aim we prepared a 329 year (1686 to 2014 C.E.) long tree-ring chronology of *Picea smithiana* based on 38 tree cores from Rambiara River Basin. This chronology is used to reconstruct the 289 years river discharge of June for the Rambiara River. The reconstruction explained 27.2% total variance for the calibration period (1981-2014 C.E.). Based on the wettest and driest years, we identified hydrological fluctuation for the last 289 years. This reconstructed river discharge is also consistent with tree-ring based precipitation and drought records of North Western Himalayas. The spectral analysis reveals that river discharge variability of the Rambiara is associated with the ENSO.

DH – PO01: Tree-ring Reconstruction of River Floods and their Effects over the Past 123 Years using *Pinus roxburghii* Sargent along Phochu River Banks

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Bhutan is dependent on the water resources not only for agriculture and consumption but also for hydropower projects. It is however vulnerable to Glacial Flood Outburst and flash floods. Awareness on the history of floods will enable the managers to prepare for future flood events. Two cores per tree from 200 trees, sixteen partial wood cross sections from scarred trees, and four circular wood discs from trees of the species *Pinus roxburghii* along the left and right river banks of Phochu River were collected for the study. The exposed roots were collected in the form of cores and discs, six root cores and four root discs were collected. Tree ring indices were compared with the river discharge of Wangdi River to reconstruct flood history. The reconstruction was done for 123 years (1985-2018); however, there was no relationship between the tree ring indices and river discharge (R^2=0.001; R^2=0.006). Floods were identified in the year 1998 and 1994 from at least 3 tree cross sections being scarred or from the first annual ring formed by the exposed roots (exposure year). A good sample depth back to 1895 was obtained with the oldest wood cross section extending back to 1920. The old disc samples show traumatic rings, but there was no consistency so, the oldest known flood event occurred in 1994 with no other recorded flood of this magnitude at least back to 1950. The 1994 flood scar was recorded in most of the trees along Pochu River which was caused by the outburst of Luggye Tsho in October, 1994. The study assessed the growth of *Pinus roxburghii* in response to flooding events; it also reconstructed the flood history of Phochu River for the past 123 years and measured the water discharge of Phochu River.

IT – OR01: Recent trends and advancement in tree-ring stable isotope analyses over the Mountain areas of Asia

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Stable oxygen and carbon isotopes are a main source of tree-ring derived reconstructions of natural climate variability and environmental trends. In High and tropical Asia, for instance, $\delta^{18}O$ variations have been shown to be suitable indicators of hydroclimatic changes over wide areas of monsoonal Asia, and can be used to reconstruct the quantity of precipitation as well as the origin of rain-bringing air masses. On the other hand, trends and extreme values in tree-ring $\delta^{13}C$ are related to variations in water-use efficiency and respond to regional droughts and to long-term changes in atmospheric CO_2 concentration. In contrast to variations in tree-ring $\delta^{18}O$ which are highly consistent between species and over larger regions, variations in tree-ring $\delta^{13}C$ are species-specific and do not correspond over longer distances. However, absolute values of isotope discrimination levels are also influenced by altitude and topography, which must be considered when reconstructing climate conditions from stable isotope variations.

The lecture presents results of analyses of tree-ring stable isotope variations along latitudinal, longitudinal and elevation gradients along the mountain regions of High Asia and reflects on physiological effects influencing the isotope ratios in plant tissue in different environments. The interrelationship between different isotope species and the added value of multiple isotope analyses will be discussed. Recent advancements in isotope dendroclimatology are introduced and major research gaps will be identified.

IT – OR02: Periodically enhanced multi-decadal tree-ring $\delta^{18}O$ variations in central Japan and their implication for East Asian 2600-year history

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East Asian history is characterized by periodical changes of Chinese dynasties (the so-called dynastic cycle) and quasi-simultaneous political regime shifts in surrounding countries like Japan. Although periodical climate variations have been investigated using sediments and stalagmites, the climatological mechanism behind the dynastic cycle has yet to be elucidated. Here, we establish a 2600-year chronology of tree-ring cellulose oxygen isotope ratio ($\delta^{18}O$), a novel proxy of summer monsoons, using a total of 67 samples of old architectural wood, excavated wooden artifacts, and naturally buried logs in addition to old living trees from central Japan. This is the longest tree-ring $\delta^{18}O$ chronology ever produced in the world. Band-pass filtering of the chronology shows that multi-decadal monsoon variation (MDMV) is enhanced about every 400 years, corresponding to the dynastic cycle. Outbreaks of internal wars at the end of Chinese dynasties and Japanese political regimes always occurred during periods of enhanced MDMV, probably because the latter induced imbalances between productivity and population. However, there are also substantial exceptions where enhancement of MDMV did not result in social instability, careful historical analysis of which may yield important lessons applicable to contemporary social conflicts.

IT – OR03: Beyond the (tree) line –the potential of shrub-ring $\delta^{18}O$ for dendroclimatological research in High Asia

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Over the past decade, considerable progress has been made in the absolute number and spatial availability of tree-ring based stable oxygen isotope time series from the Tibetan plateau and its surroundings. Fortunately, these include not only just long chronologies, but also an increasing number of studies on process-related understanding, e.g. with regard to the investigation of the various factors affecting isotope fixation during cellulose synthesis. What most of the studies have in common, however, is that they are logically limited to the eco-regions and altitudes where trees today occur. With regard to the i) former natural distribution areas of forests and ii) the mostly climatically induced altitudinal and latitudinal distribution limit of trees, wide areas in High Asia are currently not represented in the available datasets. However, these areas are extremely interesting for paleoclimatic investigations on the effects of climate change on many aspects related to the dendroclimatological and dendroecological community like research questions on responses of plant communities and projected forest distribution, e.g. on the Tibetan plateau.

The potential of shrubs in High Asia for dendroecological studies was successfully proven within several studies. However, for the development of shrub chronologies, the respective processor has to face a bunch of challenges. Known problem within the asymmetry of growth rings, wedging or absent rings lead to a consequently general challenging cross-dating issue. Nevertheless, existing studies successfully cross-dated shrubs and develop shrub-ring based chronologies that significantly reflect local climate conditions. Although the huge potential of tree-ring $\delta^{18}O$ to reconstruct past hydroclimate variability is known, only some $\delta^{18}O$ based shrub chronologies are globally available. Within this talk, we want to present three annually resolved shrub ring $\delta^{18}O$ chronologies from High Asia established from the same genus (*Juniperus*). Their dendroclimatic potential will be presented, possible uses and cross-validations to existing tree-ring $\delta^{18}O$ series evaluated.

IT – OR04: Earlywood and Latewood Stable Oxygen Isotope Variations in Pine Species Along a Latitude Gradient in Yunnan, southwestern China

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Earlywood and latewood in tree rings are produced in different seasons thus may potentially record seasonal climate signals. Tree ring oxygen isotope variations ($\delta^{18}O$) show strong precipitation signals in previous studies in southwestern China. The wide distributions of pine species in southwestern China provide us great opportunity to test whether the relationships between oxygen isotope variations and climate factors differ along a latitude gradient. In the present study, we analyzed the earlywood ($\delta^{18}O_{EW}$) and latewood ($\delta^{18}O_{LW}$) stable oxygen isotope variations in *Pinus armandii*, *Pinus kesiya*, *Pinus densata*, *Pinus yunnanensis* and their relationships with climate factors in three different sites (Shangri-la site *P. armandii* and *P. densata*, Dali site *P. armandii* & *P. yunnanensis*, and Lincang site *P. armandii* and *P. kesiya*) across Yunnan province, southwestern China. Our results showed that the intraspecies differences between $\delta^{18}O_{EW}$ and $\delta^{18}O_{LW}$ decreased with increasing latitude. $\delta^{18}O_{LW}$ series had higher mean correlation coefficients than those of $\delta^{18}O_{EW}$. We found that $\delta^{18}O_{EW}$ of *P. armandii* was negatively correlated with May precipitation across all the three sites, whereas the relationships between $\delta^{18}O_{LW}$ in *P. armandii* and precipitation did not show a stable trend across different sites. $\delta^{18}O_{LW}$ of *P. densata*, *P. yunnanensis* and *P. kesiya* were negatively correlated with October or November precipitation in the three study sites, respectively, whereas $\delta^{18}O_{EW}$ of the three pine species showed negative correlations with May and/or June relative humidity. Our study indicated that the investigation the intra-annual stable oxygen isotope variations of pine species had a potential to reconstruct the regional climate in the past in southwestern China.

IT – OR05: East Asian Summer Monsoon moisture sustains summer relative humidity in the southwestern Gobi Desert, China: evidence from $\delta^{18}O$ of tree rings

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The dominant climate-controlling system of the southwestern Gobi Desert and its surrounding areas in China at interannual to centennial time scale has not been determined. It is necessary to improve our understanding of the humidity variations in the past and forcing mechanisms in the southwestern Gobi Desert to enhance the accuracy of climate model predictions and cope with future desert advance/retreat crises resulting from climate change. We measured the annual stable oxygen isotope ratio ($\delta^{18}O$) in the cellulose of four *Picea crassifolia* trees growing on the fringe of the southwestern Gobi Desert from 1806 to 2011. Our tree-ring cellulose $\delta^{18}O$ values (34.49‰) were considerably higher than those reported in other regions of Asia, suggesting that the southwestern Gobi Desert has been extremely arid over the past two centuries. The chronology of tree ring cellulose $\delta^{18}O$ is significantly ($p < 0.01$) negatively correlated with summer (June, July, and August) relative humidity (RH) records from 12 meteorological stations nearby our study region. Based on the high correlation ($r = -0.740$, $p < 0.0001$, $n = 49$) between tree-ring cellulose $\delta^{18}O$ and instrumental summer RH from meteorological stations nearby our study region, we reconstructed summer RH variations during the past 206 years. Spatial correlation patterns between our reconstruction and several hydroclimate-related gridded data sets indicate that the reconstruction is representative of hydroclimate variations over a large area. Close agreement was observed between our reconstruction and several East Asian Summer Monsoon-related hydroclimate records. Our study indicates that the moisture from the east has introduced the RH to the southwestern Gobi Desert during the summer months over the past two centuries.

IT – OR06: Long-term growth trends and climate drivers of *Abies delavayi* on the Cangshan Mountain, Southwestern China

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Little is known whether trees growth accelerating with increased temperature and atmospheric CO_2 concentrations (Ca). We collected annual basal area increment (BAI) of *Abies delavayi* at two sites (ABCS, AFCS) located at Cangshan (Hengduan Mountains, Southwest China) and measured five trees annual tree ring Alpha cellulose $\delta^{13}C$ of sites ABCS. We aimed to investigated the trees grew trend, as well as the climatic factors and intrinsic water-use efficiency (iWUE) donation to trees growth. BAI reduced in recent 6 decade. For BAI residuals, sites ABCS decreased significantly in 1800-1950 periods, while sites AFCS decreased but not significantly at this period; from 1950 to 2016, both sites decreased heavily markedly. In site ABCS, leaf intercellular CO_2 concentration (Ci) and iWUE increased. Mean Ci/Ca rations observed was closer to Ci = constant indicated gas-exchange weakens. Commonality analysis model (CA) results revealed Ca and annual average maximum temperature (Tmax) explained 63.26% and 2.26% (total arrived 93.06%) to iWUE respectively for raw data however, 0.67% and 26.23% explanation for first difference data, which illustrated iWUE increased most result from increased Tmax. Pure effect of iWUE (45.02%) explained more for BAI residuals than relative humidity (RH, 8.67%) and Tmax (0.03%) for the raw data; For first difference data, all factors contributed less (10.14% totally). Linear regression showed BAI residuals negative correlation with iWUE for raw data, but positively correlated for first difference data. All results demonstrated that *Abies* growth decreased in those sites and increased iWUE didn't donated much.

IT – OR07: A tree-ring $\delta^{18}O$ based October relative humidity reconstruction since AD 1725 in the Gaoligong Mountains, Southwest China

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It is very important to understand the pattern of long-term climate fluctuation in monsoon region, especially Southwest China. In this study, we developed a tree-ring $\delta^{18}O$ chronology of *Tsuga dumosa* from Gaoligong Mountains (25°412 N,100°062 E), belong to the Hengduan Mountains of Southwest China, spanning 291 years (AD 1725-2015). The correlation analysis showed that tree-ring $\delta^{18}O$ from *Tsuga dumosa* has significant positive correlation with the monthly mean temperature and monthly mean minimum temperature in November and December. And, tree-ring $\delta^{18}O$ from *Tsuga dumosa* showed the highest negative correlation with relative humidity in October ($r = -0.54$, $P < 0.05$). Therefore, we used tree-ring $\delta^{18}O$ to reconstruct October relative humidity during 1725-2015, which accounted for 29.6% of the variance of actual relative humidity for the calibration period 1958–2002.

The reconstruction revealed three dry periods during 1768–1800, 1878–1944 and 1971–2015, and a general trend of getting arid gradually during the past 291 years. Meanwhile, the dry periods in our reconstructed result were evidenced in other regional drought or precipitation reconstructions from the Hengduan Mountains and nearby regions. Moreover, wavelet analysis and teleconnection analysis indicated that the variability of relative humidity in October in Gaoligong Mountains may be linked to El Niño–Southern Oscillation (ENSO) due to sea surface temperature variation in the central and east Pacific Ocean.

TD – OR01: Multidecadal Climate Response on Teak ring width along Western Ghat

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Westernghat (WG) Mountain, oriented north-south and parallel to the coast of the Arabian Sea, receives copious amount of rainfall during Indian Summer Monsoon (ISM; June-September). The latent heat released from this rainfall maintains large scale circulation and modulates monsoon flow. Based on instrumental monthly rainfall data (1871-2014), a recent study has documented a significant latitudinal variation of rainfall along WG (Kerala and Karnataka experience lowest and highest rainfall respectively). This study further shows a long term positive trend of rainfall amount in Northern WG but a decreasing trend in the southern WG; however, the rainfall of entire WG is found to be correlated with Nino SST and Indian Ocean Dipole (IOD). The ring width indices (RWI) of tropical teak have long been considered as a reliable proxy for studying past rainfall variation. In order to address whether the similar rainfall trend is archived in the natural proxies and, more importantly, to obtain additional information along this direction beyond the period of instrumental observation, the current study presents RWI chronologies (> 250 years) from three locations- Dahanu (Maharashtra, North WG), Nagerhole (Karnataka, Central WG) and Sunkham (Kerala, Southern WG). Preliminary analyses show considerable positive responses of monsoon, post monsoon and annual local rainfall in RWI, however the responses to ISM Rainfall is weak. Interestingly, the RWI show significant positive responses with post monsoon soil moisture obtained from PDSI dataset. In accordance with the earlier study, some negative correlation with IOD index is also noted.

TD – OR02: Conservation of ecologically important tree species (*Quercus serrata*) through tree ring analysis in northeast India

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Tree ring analyses provide useful insight into past and present patterns of tree growth in accordance with the climate and forest disturbance in the area, and can be used for the development of better forest management plans for conservation of trees, especially keystone species. *Quercus serrata* has been widely distributed in the hills of Mizoram and Manipur and the species play an important role in maintaining ecological balance of the region. In spite of very high socio-ecological value, the species also play an important role in soil and water conservation in the region. Additionally, species supports epiphytes including lichens, bryophytes, ferns, orchids etc. Further, species produces high quality timber that is widely used as fuel wood for cooking because of less smoke, tools for agriculture and leaves as a green manure in the agricultural practices. The growth of *Q. serrata* has been significantly affected by the changes in climate, age, forest disturbance regimes and insect and pests attack. In Mizoram, it has been noticed that due to increasing age, trees are adversely affected by climate variability and insects and pests attack, and therefore, becomes hollow from inside and significantly loses their economic value and ecological importance in the ecosystem. Inter annual tree species response to climate variability can better be correlated by studying tree ring data and climate patterns for the last several decades by preparing tree ring chronologies, and the information will be useful for preparing a better management plans that can be used for conservation of species.

In this study, a 47 (1971-2017) years long tree ring chronology of *Q. serrata* was developed using 31 tree cores of 16 trees from Champhai Forest Division of Mizoram, India. The chronology showed a good dendrochronological potential of species (Series Intercorrelation = 0.373, mean sensitivity = 0.222, SD = 0.208, AC-1= 0.063). Further, it reflected positive results in correlation analysis between event years and climatic data. However, the results obtained were not significant which is presumably because of less sample sizes (i.e. core samples) that need to be improved. This showed that the tree ring analysis in relation to climate and other factors has great potential to understand the tree response to different external forces and to develop a better management plans that can be used for conservation of ecologically important oak (*Q. serrata*) species of the region.

TD – OR03: Spatial drought and pluvial assessment of Kerala based on tree-rings of *Tectona grandis*

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Tree-ring record of teak (*Tectona grandis*) was analysed using point-by-point regression approach to reconstruct the Standardized Precipitation Index (SPI) for the districts of Kerala, South India. The state of Kerala is in the southernmost region of the Indian Peninsula and is the entry zone of the Monsoon winds into the Indian landmass. The samples collected from living and dead trees were studied and a chronology spanning 1590-2000 C.E. was prepared. The relationship of May month SPI of each of the 14 districts of Kerala and the tree-ring chronology was significantly positive. This established the basis for the spatial reconstruction of May SPI for each of these districts. The calibration and verification statistics proved the strength of each reconstruction model. Spectral analysis of reconstructed SPI brought out the existence of 2-5 years cyclicity signifying the influence of ENSO on the moisture pattern of the region. The reconstruction also recorded historical drought years of 1871, 1873, 1876, 1891, 1899, 1905, 1918, and 1937 that had impacted the socio-economic structures of Kerala. We also compared our reconstructed SPI with rainfall records of Southern Peninsular India, Homogenous Peninsular India and Kerala subdivision. The agriculture of Kerala is primarily dependent on the Monsoon rainfall, which has its impact during drought conditions and pluvial fluctuations. We attempt to understand the spatial pattern of these changes in the precipitation conditions as the arrival of Monsoon in Kerala marks the beginning of the Monsoon season and its onward strength and duration in the Indian landmass.

TD – OR04: The effects of atmospheric CO_2 and climate on intrinsic water-use efficiency of three tropical moist forest tree species from Bangladesh

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The ratio of carbon fixed by assimilation to water lost by transpiration through stomatal conductance (intrinsic water-use efficiency, iWUE) shows a long-term increasing trend across the globe. However, the drivers of long-term trends and short-term (inter-annual) variability in iWUE of tropical trees are poorly understood. We studied the long-term trends and inter-annual variability in iWUE of South Asian tropical moist forests trees derived from tree-ring stable carbon isotope ratio ($\delta^{13}C$) in response to variations of environmental conditions. We found a significantly decreasing trend in carbon discrimination ($\delta^{13}C$) and an increasing trend in iWUE in all the three species, with a species-specific long-term trend in inter-cellular CO_2 concentration (C_i). Growing season temperatures were the main driver of inter-annual variability of iWUE in *Chukrasia tabularis* and *Lagerstroemia speciosa*, whereas previous year temperatures determined the iWUE variability in *Toona ciliata*. Vapour pressure deficit (VPD) was linked with iWUE only in *C. tabularis*. Differences in life history strategies and tree architecture might have caused this species-specific variation in iWUE response to climate. Linear mixed effect modeling (LME) successfully simulated iWUE variability, explaining 41-51% of the total variance varying with species. Commonality analysis (CA) revealed that temperatures had a dominant influence on the inter-annual iWUE variability (64-77%) over precipitation (7-22%) and atmospheric CO_2 concentration (3-6%). However, the long-term variations in iWUE were explicitly determined by the atmospheric CO_2 increase (83-94%). Our results suggest that elevated CO_2 and concomitant global warming might have detrimental effects on gas exchange and other physiological processes in South Asian tropical moist forest trees.

TD – PO01: Xylem anatomical responses of two ring-porous tree species to climate in a moist tropical forest in Bangladesh

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Wood anatomical time series are very useful to understand ecophysiological responses of trees to environmental changes. However, this cellular dendrochronological approach has not been adequately applied in tropical regions. South Asian moist tropical forests are strongly understudied in this respect. We developed tree-ring width (TRW) and wood anatomical time series of two ecologically contrasting trees, *Toona ciliata* M. Roem. and *Lagerstroemia speciosa* (L.) Pers. from a moist tropical forest in Bangladesh. The two species differ in their successional stage, shade tolerance, wood density, xylem porosity, growth rates, canopy position and habitat preferences. Among several vessel variables measured, we selected two vessel variables according to their high inter-correlations, i.e. mean vessel area (MVA) and vessel density (VD) and evaluated their response to annual climate variability. Measurements of vessel variables were performed on digital microscopic images. Standard dendrochronological procedures were applied to develop vessel and ring-width chronologies. Bootstrap correlation analysis revealed that pre-monsoon temperature negatively influenced TRW and positively influenced VD in *T. ciliata*. Precious year summer monsoon season temperature negatively affected mean MVA. We found strong correlations between previous year temperatures and precipitation with vessel features and radial growth of *L. speciosa*. Current year October precipitation was positively related with MVA in both species. The observed variation in xylem anatomical responses to climate between the two study species might be linked with differences in functional traits and life-history strategies of the studied species.

WA – OR01: Wood Formation in Pure and Mixed Natural Stands of Hornbeam (*Carpinus betulus*) in the Hyrcanian Forests

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According to the importance of Hornbeam (*Carpinus betulus* L.) in Hyrcanian forests, studying cambium activity of this species with respect to different tree diameter classes in pure and mixed forest stands can present information about the growth of these trees. Therefore, wood formation and cambium phenology were studied in three different breath height (DBH) diameter classes i.e. 25-35, 36-50 and 60-90 cm (C1, C2, and C3, respectively) during the 2016-growing season in north of Iran. The method used in this study was to select a total of 2160 micro-cores from trees and further microscopic examinations.

The results showed that there was a significant difference in the wood formation between pure and mixed stands. Trees in mixed stands with different ages were generally more synchronized than the pure stand. While trees in different diameter classes of mixed forest started their cambium activity contemporaneously and 1-3 weeks earlier than pure stand, overall duration of growing season was shorter in the mixed stand. However, the production rate of the cells in the mixed stand, despite the less time of the wood formation, is greater than those the pure stand.

In both forest stands, in terms of the cambial phenology and tree-ring growth, C3 (older trees) differed profoundly from C1 and C2 (younger trees); although this difference in mixed stand was less pronounced. In Pure stand, trees with smaller stem diameter showed earlier onset of cambium activity, later cessation of growth and higher radial increment than those with larger stems but these differences diminished in mixed stand.

Overall, it was concluded that C1 and C2 trees were in the same phase of maturity and thus the timing of their growth were similar. Moreover, hornbeam trees can grow better and more sustainable in mixed stand than pure one because of less intra-species competition stress.

WA – OR02: Influence of climate variables on cambial variation of *Pinus latteri Mason* and *Pinus kesiya* in North Thailand

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Pinus latteri Mason and *Pinus kesiya* at Bo Keaw Silvicultural Research Station, Chiang Mai province, Thailand were selected to examine the influence of climate on cambial activity and wood formation. The block samples between inner – bark and wood of five trees from both species were taken by using chisel, cutter, and hammer in monthly interval from October 2017 to November 2018. The cambial activity was determined by cutting with a rotary microtome at 15µm, using safranin O and fast green for staining and counting the number of cambial cell layer. We investigate the correlation between number of cambial cell layer and climate factors such as soil moisture, rainfall, relative humidity, and temperature using Pearson's correlation method analysis. The results reveal that the cambial cell of *Pinus latteri* Mason and *Pinus kesiya* were active formation during the rainy season from May to November and dormancy during dry season from January to April. We found a significant positive correlation with rainfall ($r = 0.542$, $p > 0.05$) and humidity ($r = 0.713$, $p < 0.01$) on the cambial cell of the both species. Knowledge and understanding of cell variation in tropical trees can indicate weather variations and factors that stimulate tree cells to divide and stop growing. In addition, these results can be explained and better understanding about the research of dendrochronology in the tropics.

WA – OR03: Seasonal radial growth of *Toona ciliata* from tropical forests with contrasting soil water status in Xishuangbanna, SW China

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Tropical forests are important components of the global carbon cycle. But the intra-annual growth of tropical forest trees is understudied. High resolution dendrometer and cambial activity analysis are two important methods to investigate tree intra-annual growth patterns. Water deficit in dry seasonal could be an important limiting factor for tropical seasonal dry forest trees. We hypothesized that the growth of *Toona ciliata* (Meliaceae) from a tropical dry forest (karst forest) will be more limited by water deficit in the dry season than in a tropical wet forest (tropical rainforest). We monitored the seasonal growth pattern of *T. ciliata* with both micro cores and dendrometer in two forests with contrasting soil water content in Xishuangbanna, SW China. Our study showed that the growth of *T. ciliata* is more limited by spring (February to April) drought stress in the karst forest than in the tropical rainforest. However, there are great variations among different individuals within the same forests, which could be related to their difference in DBH and age. The growth of *T. ciliata* started in January in both the karst forest and tropical rainforest, which is in consistent with the findings from central Thailand. Our study provides detailed information about the intra-annual growth pattern of *T. ciliata* from Asian tropical forest.

WA – OR04: Trees flexing with the weather: evidence for an additional month of stem growth after the "normal" growing season

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The impact of extreme, transient meteorological events on tree growth is a fundamental question in ecology. One way to investigate how trees might respond to such events is the study of intra-annual density fluctuations (IADFs) of tree cambium using high frequency micro coring. We investigate the formation of an IADF in 2016 observed in three of five *Juniperus przewalskii* trees that had been micro cored weekly or biweekly from 2011-2016 over the northeastern Tibetan Plateau. An additional month of radial growth, relative to the end of growth over the prior five years, was observed in 2016 for these trees upon experiencing warm and wet conditions following a 16-day with no measurable rain at the end of the growing season. Extra-seasonal growth resulted in an additional accumulation of stem biomass equating to 0.043±0.005 kg per tree. Observations of photosynthetic rates in four additional trees at this site indicate that IADFs might be a product of source-driven dynamics. Our results highlight the extraordinary plasticity and resiliency of trees and suggest that some individuals can make use of environmental resources after what had been observed to be the end of the growing season.

WA – PO01: Inter-annual growth pattern of Chir pine in subtropical Nepal from 2016-2018

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Intra-annual growth variations in trees are influenced by various climatic and edaphic factors. However, a detailed exploration and evaluation of the respective climatic impact on tree-growth with high temporal resolution is crucial to understand the effect of climate on (sub-annual) growth patterns. Chir pine (*Pinus roxburghii*) is a native species growing under subtropical conditions along the southern declivity of the Himalayas, and is an ecologically and economically important tree species in Nepal. Within this study we present the first approach to evaluate and understand radial growth of *P. roxburghii* on different temporal scales in subtropical Nepal. Four trees growing at an elevation of 1300 m asl in the Kathmandu basin were equipped with band dendrometers measuring stem circumference variations at 30 minute intervals. First results revealed that tree growth started in the first week of March and continued until the first week of October. The average growth rate of trees during the growing period 2016 was less than in 2017 which was related to drier conditions during March and April at the beginning of the growing season in 2016. In 2016 and 2017, maximum growth rates were recorded during the peak of the summer monsoon season during June to July except for 2018. We found close relationships between stem circumference increment and different climate parameters like air temperature, precipitation, and humidity. The correlation between circumferential growth and rainfall was statistically significant and positive on all temporal scales at $p>0.01$ for both years. However, the relationship became stronger in temporal resolutions of 15 days and 21 days. Interestingly, the frequency of rainfall events had a stronger impact in controlling growth than the absolute amount of rainfall. This indicates that dry periods occurring during the growing season reduce the growth rate and contribute to the formation of inter-annual density fluctuations.

TL – OR01: Alpine treelines on the Tibetan Plateau: an integrative understanding from xylogenesis to ecosystem

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The Tibetan Plateau hosts the world's highest natural treelines, being potentially sensitive to climate change. Based on weekly xylogenesis monitoring since 2007 on the Tibetan Plateau, we aim to answer these questions: what is the physiological mechanism for alpine treeline formation based on nature treelines on the Tibetan Plateau? Whether are there significant changes in structures and patterns of alpine treeline? Spruce, fir and juniper treelines under different macroclimate across the Tibetan Plateau were selected to monitor microclimatic conditions, weekly wood formation and leaf phenology. A network of alpine treeline plots were set up to retrieve spatiotemporal variations of alpine treelines on the Tibetan Plateau and surrounding areas. In the semi-humid treeline, the onset of cell division has a very low threshold minimum temperature that determines the length of the growing season, and drives treeline formation in sub-humid areas. In the drought-prone treeline in the northeastern Tibetan Plateau, the onset of cell division was controlled by both temperature and precipitation thresholds. As showed by treeline plots, climatic warming tended to promote an upward shift of alpine treelines at a large scale in the last 100 years. However, upslope migration rates were controlled largely by interspecific interactions in the eastern Tibetan Plateau and precipitation in the central Himalayas. It both helps to explain why many treelines have not advanced in response to climatic warming and highlights that predictions of treeline shifts based solely on climate may be misleading. In addition, the alpine treeline ecotone can be considered to be a simplified model of forest ecosystem to study global ecology and climate change.

The above findings have been presented on behalf of a working group.

TL – OR02: Rate and duration of stem radial increment contributing to annual increments of *Picea meyeri* in a sub-alpine habitat, north-central China

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Stem radial increment rate and duration are the most important parameters in determining the width of annual tree rings. To identify the contributions of rate and duration to annual radial increments and their relationships with environmental factors, we analyzed intra-annual stem increments of five *Picea meyeri* trees in a subalpine habitat of North-Central China over 7years (2008–2015, except for the year 2012) with point dendrometers in this study. The results showed the following. (1) We estimated that approximately 53% of the variability in the annual radial increments is attributable to the rate of radial increment and approximately 47% to its duration. (2) The contribution of cessation time to the annual increments was more than three times that of the initiation time. (3) The initiation of radial increment was primarily controlled by soil temperature and warmer soil temperature could advance the initiation time. The cessation and rate of radial increment were mainly influenced by thermal and light-related environmental factors. During growing seasons, low temperatures and insufficient light caused by many rainy and cloudy days at the high altitudes of the Luya Mountains may result in earlier cessations and lower rates of radial increment. Overall, our results may have further applications in modeling the responses of tree stem growth to climate change in a sub-alpine habitat of north-central China.

TL – OR03: Moisture-mediated responsiveness of treeline shifts to global warming in the Himalaya

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Among forest ecosystems, the alpine treeline ecotone can be considered to be a simplified model to study global ecology and climate change. Alpine treelines are expected to shift upwards in response to global warming given that tree recruitment and growth are assumed to be mainly limited by low temperatures. However, little is known whether precipitation and temperature interact to drive long-term Himalayan treeline dynamics. Tree growth is affected by spring rainfall in the central Himalayan treelines, being good locations for testing if, in addition to temperature, precipitation mediates treeline dynamics. To test this hypothesis, we reconstructed spatiotemporal variations in treeline dynamics in 20 plots located at six alpine treeline sites, dominated by two tree species (birch, fir), and situated along an east-west precipitation gradient in the central Himalayas. Our reconstructions evidenced that treelines shifted upward in response to recent climate warming, but their shift rates were primarily mediated by spring precipitation. The rate of upward shift was higher in the wettest eastern Himalayas, suggesting that its ascent rate was facilitated by spring precipitation. The drying tendency in association with the recent warming trends observed in the central Himalayas, however, will likely hinder an upslope advancement of alpine treelines and promote downward treeline shifts if moisture availability crosses a critical minimum threshold. Our study highlights the complexity of plant responses to climate and the need to consider multiple climate factors when analyzing treeline dynamics.

TL – PO01: Viable inferences of tree-ring analyses for the response of *Abies spectabilis* at treeline ecotone, Garhwal Himalaya

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Treeline acts as a biomonitor of climate change and has developed a sensational place in the scientific community in recent years. However, the understanding of treeline dynamics is challenged by the complex interactions of factors that control treeline and the species growing near to it. To understand climate change effects on treeline species and their transposition in the western Himalaya, the selected study site is the summer monsoon dominant Tungnath area (30°29'-30°30'N Lat and 79°12'-79°13'E Long) located in the vicinity of Kedarnath Wildlife Sanctuary. Tree ring samples were collected from the *Abies spectabilis* (silver fir) within the altitude range of 2800 – 3400 m asl covering the treeline ecotone, and analyzed for the relationship between its growth and affecting climatic variables. Climate - tree growth response analysis shows significant positive relationship of ring width indices with the temperatures of previous year November and current year February months. Accordingly, based on the tree-age data, treeline shift rate for Chopta-Tungnath transect is estimated around 1.37 m year^{-1}. Results also indicate that the climate as well as other local factors have significant role in controlling the growth and tree line dynamics of silver fir at the Tungnath area for the past 300 years. Moreover, the occurrence of fir trees younger than 100 years within the forest ecotone limit might be the result of observed increasing trend in the winter temperature during the 20th century. Further investigations on the overall survival and growth of silver fir in relation to climate and other factors would play an important role to understand the treeline dynamics and the response of treeline species with varying climate.

FE – OR01: Dendroecological studies in China

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Dendroecological studies in China have been growing rapidly in the past decade, touching a wide variety of ecological phenomena including natural disturbances, resilience to climate extremes, tree growth declines, treeline ecology, cambium activity and its relationships to phenology, as well as tree growth response to global climate change. The aims of the talk are to review progress and to outline research gaps for future studies. Tree-ring data for ecological studies in China have been continuously accumulated covering a broad region of different geographical characteristics. Particularly, tree rings on the Tibetan Plateau, which are usually considered sensitive to global climate change, reveal strong resilience to climate extremes, a beneficial characteristic for their survival of adverse environments. Future perspectives include comparisons of growth response to different disturbances, on ecological gradients, over different time intervals, and in different tree species to further reveal the patterns of tree growth response to environmental changes. Monitoring tree growth in permanent forest plots is useful for detecting fine-scale tree growth processes. Additionally, experimental studies of trees' ecophysiology are valuable to understand mechanisms of growth changes in trees and to predict growth responses to future climate change. Examples of tree-ring studies will be used to illustrate the current progresses and future perspectives.

FE – OR02: The return of the variance: tree-ring variability in two sites under different water regime.

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Standard analyses in dendrochronology and dendroclimatology focus mostly on mean tree-ring characteristics. In dendroclimatological studies the common procedure is to exclude non- climatic variability in order to emphasize the effect of climate on tree rings. In our study we compared mean and variance of tree-ring widths of Norway spruce from two sites. In 2013, 200 tree core samples were taken from two Polish spruce forests with different habitat conditions. Site 1 was humid with water stagnation less than a month and site 2 less humid with no stagnated water. The variance and mean of tree-ring widths differed before and after massive insect outbreak in the years 1978-1985. Due to this outbreak 76 missing rings in years 1981-1983 were observed in trees growing in the less humid site. Before insect outbreak the mean ring widths for the humid site was 2.81 and for the less humid 1.63, after outbreak 2.23 and 2.58 respectively. The mean values of tree-ring widths in the years 1952-1980 were significantly different ($p(F)<0.01$), while respective differences were not observed in the years 1984-2012. As expected, before the insect outbreak a significant higher ($p(F)<0.01$) variance was observed on the humid site with the on average wider tree rings. After the insect outbreak the situation was opposite, a significant higher ($p<0.01$) variance was observed on the less humid site but the mean tree ring widths did not significantly differ. This study shows that spruce on less humid sites might be more sensitive to insect outbreaks. However, after outbreak, trees recover and ring widths are comparable to unaffected trees.

FE – OR03: Fire history and climate-growth response of *Abies spectabilis*: A case from Langtang National Park, Nepal Himalaya

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This study present the potential of a conifer species (*Abies spectabilis* D. Don) to reconstruct fire history by using dendrochronological technique along with the dendroclimatic response in Langtang National Park, Central Himalaya of Nepal. For the fire history reconstruction, altogether eight cross-sections samples from fire affected eight trees and another 20 tree-cores from 10 fire scars visible tree were taken. Whereas for dendroclimatic study, 24 healthy cores of *Abies spectabilis* were selected from the collection of 40 cores extracted from 19 trees. The standard dendrochronological methodology was used for sample preparation and analysis. A 199-year long ring width chronology of *Abies spectabilis* spanning from 1818 to 2016 AD was developed. In spite of visible fire burn in near bark surface, no potential fire scars are seen in inner parts in the cross-section samples. However, 12 cores showed that three fire burns occurred simultaneously in the forest area in the years 1917-1918, 1969-1970 and 2009-2010, respectively. Tree-ring based fire event record is concurrent to local people's perceptions/experience about the past fire history in the area. Tree growth climate relationship shows sensitive responses to both growing and non-growing season's temperature and precipitation variability. Summer temperature has a positive influence on growth of the species. Precipitation of monsoon and autumn have the negative influence on radial growths whereas, pre monsoon precipitation strongly positively associated with tree radial growth. As the study was pilot study to find out the potential of this species to reconstruct fire history, this preliminary assessment shows that there is a huge potential of tree-ring research for long term fire history in the region and better understand the role of fire in the ecology and management in Himalaya region. The study can also be replicated in other fire-prone areas of Nepal Himalaya by using fire sensitive species in the sampling.

FE – OR04: Tree growth characteristics associated with potential risk of tree mortality in Northern Hemisphere, derived from tree-ring data in International Tree-Ring Data Bank

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Several studies have documented that regional climate warming and the resulting increase in drought stress haven triggered increased tree mortality at global scale, prompting interest in better understanding tree mortality processes. We compared radial growth characteristics (e.g. tree growth variation) between paired live and recently dead individuals from 23 sites with forest mortalities, and estimated the potential risk of tree mortality at Northern Hemisphere scale, based on tree-ring data from International Tree-Ring Data Bank. We observed that tree growth variation was significantly correlated with tree mortality ($R^2 = 0.37$, $P < 0.05$), indicating tree growth variation as an indicator of potential risk of forest mortality. In areas with low precipitation but high precipitation variation, Tree growth variation is significantly higher than that in other areas (0.28 vs. 0.24, $P < 0.05$), which has a similar spatial distribution with the documented forest mortalities. Tree growth variation significantly increased since 1970 in Northern Hemisphere, especially in areas with low precipitation but high precipitation variation. These results suggested that increased aridity and annual precipitation variation may lead to higher tree growth variation, which indicated increasing potential risk of forest mortality.

FE – OR05: Enhanced stem starch accumulation but reduced tree-growth caused by June drought for semi arid forests in Inner Asia

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Isolated patchy forests in semiarid Inner Asia are facing increasing risk of forest mortality with increasing drought frequency. We systematically cored all tree individuals of *Larix sibirica* dominated forest patches of different sizes at 7 sites with different mean annual precipitation (MAP) in northern Mongolia in August 2017. Leaves and branches for each plot were also sampled. Tree-ring chronology was established and non-structural carbohydrate (NSC) was measured for all the plots. We also sampled and measured seasonal NSC dynamics for two tree species between wetter and dryer sites in the arid timberline of northern China. Our results show that: temperature of the current and previous June negatively but June precipitation of the same months positively correlated with ring-width significantly, so does the current year Palmer Drought Severity Index (PDSI); (2) the MAP determines the leaf and stem soluble sugar (SS), leaf and branch starch concentrations of *Larix sibirica*. The branch stores more starch at lower MAP; (3) the starch in stems is significantly higher for both conifer and broadleaf tree species shows at drier sites in the dry year 2017 than the normal year 2016. Our results suggested that: (1) trees in the semiarid forests in Inner Asia show reduced tree growth but allocate starch in the stem to resist early summer drought, (2) drought event but not climate regime determines NSC allocation, and (3) early summer is critical to tree-growth for semiarid forests in Inner Asia. Our study implied that trees in the semiarid forests in Inner Asia have a strong resilience to seasonal drought events through physiological adjustments while high risks of forest mortality might occur after a multi-year drought.

FE – OR06: History of tree growth declines on the Tibetan Plateau

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Tree growth declines associated with global warming have received much research interest. It is relatively less studied about the tree growth declines in the pre-warming history. Lack of information about the historical tree growth declines hinders our understanding of their natural range of magnitude and, thus, limits our ability to evaluate whether the recent decline episodes represent novel events associated with the global-change-type droughts or they are a kind of recurrence of a natural phenomenon linked with trees' vulnerability to a multitude of stresses. Here we address this question by studying historical growth declines in juniper trees (*Juniperus przewalskii and J. tibetica*) on the Tibetan Plateau (TP), a region sensitive to global climate change due to its vast area of high elevation. We sampled a network of 48 juniper forests across TP and obtained tree-ring widths sequences from 1429 trees. We found that tree growth declines occurred several times in the past three and a half centuries, and these decline events had different spatial characteristics. Our results suggest that tree growth declines on the Tibetan Plateau is not a novel phenomenon associated with global warming but occurred in pre-warming conditions.

FE – OR07: Physiological and growth responses to increasing drought of an endangered tree-species in southwest China

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Drought–induced tree decline and mortality are increasing in many regions around the world. Despite the high number of studies that have explored drought–induced decline, species-specific responses to drought still makes it difficult to apply general responses to specific species. The endangered conifer species, *Fokienia hodginsii*, have experienced multiple drought-induced mortality events in recent years. Our objective was to investigate the historical and current responses to drought of this species. We used annually resolved ring–width and $\delta^{13}C$ chronologies to investigate tree growth and stand physiological responses to climate change and elevated CO_2 concentration (C_a) in both dead and alive trees between 1960 and 2015. Leaf intercellular CO_2 concentration (C_i), C_i/C_a and intrinsic water–use efficiency (iWUE) were derived from $\delta^{13}C$. The $\delta^{13}C$ were positively correlated with mean vapor pressure deficit and PDSI from previous October to current May, while ring widths were more sensitive to climatic conditions from previous June to September. Moreover, the relationships between iWUE, basal area increment (BAI) and C_i/C_a changed over time. From 1960s to early 1980s, BAI and iWUE maintained a constant relationship with increasing atmospheric CO_2 concentration. After the mid-1980s we observed a decrease in tree growth, increase in the frequency of missing rings, and an unprecedented increase in sensitivity of $\delta^{13}C$ and radial growth to drought, likely related to increasingly drier conditions. We show that the recent increase in water stress are likely the main trigger for the unprecedented decline in radial growth and spike in mortality of *F. hodginsii*, which may have resulted from diminished carbon fixation and water availability. Given that the drought severity and frequency in the region is expected to increase in the future, our results call for effective mitigation strategies to maintain this endangered tree species.

NT – OR01: Site- and species-specific climatic responses of two co-occurring shrubs in the temperate Alxa Desert Plateau, northwest China

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In the context of global precipitation anomalies and climate warming, the evolution of fragile desert ecosystems, which account for one-third of the world's land area, will become more complex. Studies of regional climate change and ecosystem response are important components of global climate change research, especially in arid desert regions. *Zygophyllum xanthoxylum* and *Ammopiptanthus mongolicus* are two dominant but endangered shrub species in the Alxa Desert in the arid region of central Asia. Using dendrochronological methods, we studied the response of radial growth of those two species to climate factors, and the adaptability of the two shrub populations under a regional warming trend. We found that radial growth of both shrubs was mainly affected by precipitation during the growing season. In additionally, along with the decrease of precipitation and the increase of temperature from east to west of Alxa desert Plateau, the limiting effect of drought during the growing season on radial growth increased. The climate response characteristics and changes between dry and wet periods exhibited spatial and temporal heterogeneity due to micro-level geomorphological factors. Under a regional climate-warming trend, individual growth and population development of the two endangered shrubs will be adversely affected. In areas where these species are naturally distributed, populations will gradually become concentrated in micro-geomorphic regions with better soil moisture conditions, such as low-lying areas in the gullies that develop in alluvial fans. This finding has important scientific significance for understanding the development of the region's dominant shrub populations and protection of these and other endangered plants in arid desert areas.

NM – OR01: Natural hazards reconstruction based on tree-ring data from the Himalaya

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Trees impacted by the forces of natural processes such as flash floods, snow avalanches, landslides, rock falls or earthquakes record exhibit growth disturbances in their growth-ring series. These are mostly marked by the reduction in annual ring width and/or the formation of reaction wood, callus tissue or tangential rows of traumatic resin ducts. These disturbed rings could be datable and provide an excellent signal for the spatio-temporal reconstruction of past natural hazard activity and provide a means to date and document past disasters. Several tree species and sites have been inventoried across the different basins of north-western Himalaya i.e. Beas, Ravi, and Chenab. We ascertain that the tree-ring techniques could be of wide applicability in the analysis of natural hazards across the Himalaya.

NM – OR02: The Jordaens Van Dyck Panel Paintings Project – first dendrochronological insights

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The Jordaens Van Dyck Panel Paintings Project is an innovative multidisciplinary art historical initiative that is systematically studying the oil paintings on oak panels by Jacques Jordaens (1593-1678) and Sir Anthony Van Dyck (1599-1641). An ongoing dendrochronological survey of nearly 300 oil paintings, combined with the study of the Antwerp panel makers' and Guild brand marks on the reverse of the panels, new archival research and traditional art historical scholarship, aims at a better understanding of the lives and works of these artists and paintings on wood panels in the 17th century.

Here we present first results of non/micro-invasive dendrochronological analyses and the dating of 343 oak planks of 170 paintings. So far, 64% of the paintings were dated and the heartwood dating can often be pinpointed to a narrower period using Antwerp panel makers' and Guild brand marks. Moreover, most of the oak trees used for the planks of the wood panels originate from mostly two non-specific regions within the former Baltic region (Baltic 1 and Baltic 3 reference chronologies). Comparison of the tree-ring series between all planks further shows that some planks utilized for the different wood panels, and thus different paintings, were even taken from the same tree. This comprehensive art historical-dendrochronological approach provides new insight into the collaboration between the two famous Flemish painters and the temporal succession of the paintings that are now located in various museums around the world.

NM – OR03: Synthesis approach of remote sensing and dendrochronology to reconstruct long-term inter-annual vegetation productivity for the Himalayan region

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Against the backdrop of ongoing debate on the rising global temperature and atmospheric CO_2 concentration, investigating the response of these factors on the net primary productivity (NPP) could lead to a better understanding of forest growth dynamics. Recently few studies looked into this aspect by synthesizing the climatic factors and remote sensing based normalized difference vegetation index (NDVI) with the tree ring width index (RWI). NDVI represents the density of healthy vegetation, and this approach is entirely missing for the Himalayan region, which is having high NPP. Remote sensing tools allow to critically monitoring the NPP using different indices and also allow wider applications in terms of continuous monitoring and covering the large area. In this study we provide a maiden attempt to identify the relationship between RWI and satellite-derived NPP and NDVI time series products on varying timescales and spatial resolutions for the Himalayan region. The analyses are underway and findings could represent an important breakthrough for estimating the inter-annual variability and long-term changes in the vegetation productivity (NPP) for the Himalayan region. The expected outcomes of present research will lead to develop adaptation policy for the forest use management and the sustainable livelihood for the local population.

NM – OR04: Paleo-Seismic signals inferred from tree-ring data in the Qadam Basin during the period of 1000-1999 CE

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As an environmental disaster, earthquakes occur with a sudden release of stored energy, which will cause huge destruction. China is one of the countries in the world with frequent occurrence of earthquakes. It is very important to explore the characteristics of earthquake occurrence and actively prepare for possible earthquakes in the future via new technologies and methods. Here we carried out integrated analyses of paleoseismic activities in the Qadam Basin of China during the past millennium via the dendrochronology method. The growth disturbances (GDs) in the Qilian Juniper (Sabina przewalskii Kom.) samples from 65 sites (6502 cores in total) were investigated and dated during the period of 1000-1999 C.E., the preliminary results showed the GDs existing in large spatial scale can be used to recover the seismic events, accordingly, eight suspected earthquake events were found, of which three events were consistent with known earthquakes and the other five events were most likely unknown earthquakes. Our research indicates that Chinese conifers indeed have a large potential to yield dates of past seismic events with tree rings, and dendrogeomorphology should therefore be used in similar environments for a better understanding of past and potential future mountain disaster processes.

NM – OR05: Species-specific resilience to droughts in long term

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With frequent occurrence and increasing intensity of extreme events in a changing climate, how forests react to extreme events is of widespread interest. Yet, there are few comparative studies to quantify growth resilience in different tree species through long-time scale. Stable oxygen isotope ratio of tree rings is closely related to the source water absorbed by trees, which can directly reflect the changes of moisture conditions in tree growing period. By comparing the sequences of oxygen isotope ratios and ring widths, we found that most of the individual tree growth would decline after the extreme droughts indicated by isotope sequences. On this basis, the species-specific resilience subjected to drought stress in long-time scale was evaluated in the past two centuries. We found that, in Mid-Himalayan region of the southern Tibetan Plateau, *Juniperus tibetica* has a faster response rate and stronger resistance and recovery to drought than *Abies spectabilis*. Furthermore, compared with *J. tibetica,* the resistance and response rate of *A. spectabilis* showed a significant increase in the last two centuries. The resilience of the two species shows a convergent trend. Our results suggest that tree resilience shows a convergent trend between *J. tibetica* and *A. spectabilis* in the last two centuries. This variant may change the structure and diversity of forest community and further influence the forest adaptation and carbon sink in global warming.

NM – OR06: Tree-ring based reconstruction of debris flow since 1758 C.E., from Lachung valley Sikkim, the Eastern Himalaya.

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The most destructive mass movement processes of natural hazards in the eastern Himalaya are debris flow and landslides. To get a better understanding of their past occurrences, frequency and triggering factors, both in spatial and temporal extent it is important to have long term data. However, in this region knowledge of past natural hazards are mostly incomplete and records of the smaller events are lacking. In this context, tree-ring data play a key role in providing valuable information on the past activity and thereby contribute significantly to hazard evaluation on annual resolution basis in longer perspective. During such geomorphological events the tree-ring record shows a remarkable reduction in the annual ring width and/or the formation of reaction wood, callus tissue, or tangential rows of traumatic resin ducts (TRDs). Here we present a tree ring based 258 years chronology of natural hazards derived from the dendro-geomorphic analysis of 184 disturbed trees of *Abies spectabilis* growing at the event sites, in and around the Lachung valley. We are able to reconstruct 26 ungauged hazard events between 1758 and 2016 C.E. The tree ring based reconstruction provides magnitude and the frequency of past events. Analysis of the tree-ring records from the three affected sites at this Lachung valley region indicate multiple periods of mass movement during the 20th century.

MP – OR01: Response of vegetation to past climate change in Central Asia: an approach combining pollen-based vegetation estimates and tree ring-based climate variables

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Central Asia is situated at the intersection between the major northern hemispheric climate subsystems and is characterized by a variety of landscapes, i.e. deserts, steppes and forests. The distribution of plant species in Central Asia highly depends on climate, soil and topography; most of the species are growing near their physiological limit making them highly vulnerable to climate change. In addition, land use influences the resilience of species to environmental changes. However, to which degree climate and land use respectively affect past and present vegetation trends in Central Asia is still unknown.

Pollen is the main proxy to explore changes in vegetation at different spatial (local to subcontinental) and temporal (decades to millennia) scales. To quantify human- and climate-induced changes in vegetation, past land-cover (pollen-based estimates), land use (human deforestation scenarios and human population size) and climate (variables derived from climate models) data can be combined, as it has been done in Europe.

This study aims at quantifying the effect of past climate changes on vegetation in Central Asia over the past millennia. For this purpose, we use pollen data from sedimentary records (lakes and mires), which were transformed into vegetation composition and diversity indices. Pollen data as point estimates and spatial grids of past vegetation are combined with available annually resolved gridded summer temperature, drought and precipitation estimates inferred from tree-ring chronologies in this region. We present potentials and challenges of combining proxies with different spatial and temporal resolutions. This multi-proxy approach provides insights into vegetation responses to past climate change in Central Asia.

MP – PO01: High resolution precipitation variability for past four centuries in the Indian Central Himalaya using speleothem and tree rings

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The stable isotope ($\delta^{18}O$ and $\delta^{13}C$) data of a ~400 years (1622 and 1950 AD) long annual to decadal-resolution speleothem record collected from the Indian Lesser Himalaya. The data show a variation from -2.7 to -5.9‰ in $\delta^{18}O$ and -5.3 to -8.8‰ in $\delta^{13}C$. The stalagmite sample is mainly composed of aragonite (both compact sub-layers and porous sub-layers). Although, the stalage model may be within age uncertainty owing to the high 230Th/232Th isotope ratios, yet the distinction of this study lies in recording various historical drought events, which are otherwise never reported from the Himalayan foothills. Moreover, the sample consists of reasonable amount of U (>2 ppm), thus the age correction requirement may be minimum. The higher growth rate and comparatively lower values of both isotopes are observed during the Little Ice Age (LIA) until ca. 1820 AD, indicating its being wet in the Himalayan foothills in contrast to Peninsular India and other regions which are solely influenced by the Indian Summer Monsoon (ISM). This is mainly because the monsoon trough moves from the plains to the Himalayan foothills during break-monsoon conditions and provides more orographic precipitation in the form of the Westerlies in the south facing Himalayan slopes. The post-LIA period from ca. 1820 AD onwards is interpreted as comparatively drier than the LIA. In addition, tree-ring width chronologies of Himalayan cedar in the nearby area within the same precipitation and temperature regime show well correlation with stalagmite record. Both proxies documented multi-year droughts at 1744-1748, 1782-1786, 1812-1816 and 1920-1924 AD and pluvial phases in 1723-1727, 1758-1762, 1788-1792 and 1911-1915.

TO – OR01: The use of Sea-Surface Temperature (SST) for dendroclimatic reconstructions: Preliminary results from the Pacific Ocean

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The equatorial Pacific El Niño–Southern Oscillation (ENSO) phenomenon is one of the most dominant modes of ocean-atmosphere variability. The environmental and socioeconomic impacts of alternating warm El Niño and cold La Niña events are experienced particularly strongly along western islands like the Philippines, Indonesia, eastern Australia and New Zealand. In this presentation, we start by showing the 'conventional' approach of using a network of tree-ring chronologies (e.g. from Australia and New Zealand) to reconstruct a regional index of sea surface temperatures – the NINO3.4 index (i.e. 5°N to 5°S, from 170°W to 120°W). However, numerous other paleoclimate reconstructions of ENSO are available and there seems little agreement between them. Concerns include the non-stationarity of teleconnections and other competing climatic influences. One alternative is to use the leading principal components from tree-ring drought atlases either side of the Pacific (i.e. the ANZDA and MXDA) to reconstruct NINO3.4 allowing for a more robust reconstruction. The final approach to be discussed is using a spatial grid of ocean sea-surface temperatures (i.e. SSTs) as the target for a reconstruction, instead of the normal spatial grid of terrestrial hydroclimate indices (i.e. PDSI). We will show preliminary results from using separate and geographically distant hydro-climatically sensitive tree-ring networks located around the Pacific rim encircling the ENSO region (i.e. the ANZDA, NADA/MXDA and MADA tree-ring networks). In this way, periods of weaker teleconnections in one region are compensated for if the signal in the other region is stronger.

TO – PO01: Tree-ring-based drought variability in the eastern region of the Silk Road and its linkages to the Pacific Ocean

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Drought variability from 1568 to 2014 was presented for the eastern region of the Silk Road by using five tree-ring chronologies and an optimal information extraction method (i.e., one of the composite-plus-scale methods). The inspection results of the split calibration-verification procedure for the transfer functions showed that the reconstructed Palmer drought severity index (PDSI) was credible throughout the entire time interval. During the past 447 years, there were seven dry periods (1616–1622, 1629–1645, 1682–1730, 1760–1778, 1805–1884, 1919–1933 and 1990–2009) and seven wet periods (1573–1615, 1623–1628, 1646–1681, 1731–1759, 1779–1804, 1885–1918 and 1934–1989). The dry periods were well-documented historical drought events. Significant interannual periods of 2.1–3.8 years and interdecadal cycles of 17.1, 18.3, 23.8, 42.7, 51.3 and 73.0 years were identified via the multi-taper method for spectral analysis. Similar patterns of drought fluctuations were found in the records of the drought/flood index and other drought reconstructions. By comparing the reconstructed PDSI with the El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) at the multidecadal scale, it was discovered that when ENSO and PDO were in phase (i.e., high-PDO/warm-ENSO phase or low-PDO/cold-ENSO phase), the study region was dry or wet more often, respectively, especially before 1850. The influence of ENSO and PDO on the decadal variability of drought has been affected by global warming.

TN – OR01: The Himalayan Dendrochronology: A scientific endeavour of international collaboration

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The Himalayas has been a symbol of challenge and inspiration to the humans since time immemorial. At a regional level, the towering range has been a climate maker and its trees the record keepers. In the tree species growing at varied altitudes from Gangetic plain to the mountain cliffs, the researchers have found an invaluable treasure of climate history spanning for many centuries. Nepal Himalaya has witnessed a significant flow of visit by international dendro-scientists from around the world and growth of scholarly publications based on their enquiry. Since the first tree-ring samplings were collected in late 1970s, over 70 studies have been carried out, and over 50 graduate theses have successfully been defended including five PhDs. Till date, over 60 research articles with dendrochronological analysis have been published in various peer-reviewed journals and proceedings involving over 270 researchers from 12 different countries.

The dendrochronological studies carried out in Nepal Himalaya have covered some 15 tree species, the most favoured one has been *Abies spectabilis* and the most widely used parameter for analysis has been the ring width. By geographic coverage, studies have been carried out in over 10 major sites of high altitudes (3000m above sea level) extending from Kanchenjungha in the east to Api-Nampa in the west. The dendrochronology laboratory at Nepal Academy of Science and Technology (NAST) has a collection of some 3,500 core samples, including those early collections of Khumbu valley which were returned from the USA. The longest chronology for Nepal was built from *Tsuga dumosa* with 1141 years that extended from 856 C.E. to 1996 C.E. The climate reconstruction studies have covered temperatures from 1546 C.E. to 1991 C.E.

In recent years, the environmental health of the Himalayas has been a major concern in context of the impending impact of climate change. Due to paucity of scientific data, it is often tagged as a 'white spot'. Notably, the researchers working in Nepal Himalaya are contributing to fulfill the gaps by studying vegetation shift at the tree-lines. NAST in association with Italy's Padova University, carried out the ûrst such study in the Everest area, where permanent plots were established in 2007. More studies in other areas have revealed an upward shift of *A. spectabilis*. Similarly, the studies have demarcated the position of tree-lines in Nepal Himalaya, which varied 4150 m asl in the east (Lat. 27.7155N) to 3800 m asl in the west (Lat. 29.8750N).

The dendrochronology in the Himalayas stands high as a scientific endeavour of international collaboration, thanks to the shared efforts of the scientists and the networking provided by Asian Dendrochronology Association.

TN – OR02: Anthropogenic aerosols cause recent pronounced weakening of Asian Summer Monsoon relative to last four centuries

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The Asian Summer Monsoon (ASM) affects ecosystems, biodiversity, and food security of billions of people. In recent decades, ASM strength (as represented by precipitation) has been decreasing, but instrumental measurements span only a short period of time. The initiation and the dynamics of the recent trend are unclear. Here for the first time, we use an ensemble of 10 tree ring width chronologies from the west central margin of ASM to reconstruct details of ASM variability back to 1566 C.E. The reconstruction captures weak/strong ASM events and also reflects major locust plagues. Notably, we found an unprecedented 80 year trend of decreasing ASM strength within the context of the 448 year reconstruction, which is contrary to what is expected from greenhouse warming. Our coupled climate model shows that increasing anthropogenic sulfate aerosol emissions over the Northern Hemisphere could be the dominant factor contributing to the ASM decrease.

TN – OR03: Seasonal Palmer drought severity index reconstruction using tree ring widths from multiple sites over the central-western Da Hinggan Mountains, China since 1825 AD

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Many evidences indicate that the drought in Northern China has progressively intensified, threatening people's lives and properties. Drought has become one of the most severe environmental problems in Northern China, and thus has serious impacts on the regional social and economic development. The present study investigated the seasonal Palmer Drought Severity Index (PDSI) over the central-western Da Hinggan Mountains (CW-DHM), northeastern China. 283 cores of Mongolian pine trees from 6 locations were used to generate a regional ring-width chronology. The chronology in CW-DHM was significantly correlated with the May–July PDSI, with an explained variance of 49% (r = 0.700, 1951–2013, p < 0.0001). The regional May–July PDSI ($PDSI_{5\text{-}7}$) from the CW-DHM was reconstructed from 1825 to 2013 AD. The ensemble empirical mode decomposition method (EEMD) and multi-taper method (MTM) spectral analysis revealed that the cycles in the reconstructed $PDSI_{5\text{-}7}$ were close to those of the ENSO and solar activity. This suggests that both the ENSO and solar activity have strong influence on the $PDSI_{5\text{-}7}$ variation in the CW-DHM region. In addition, EEMD also revealed that the Pacific decadal oscillation and the Atlantic multi-decadal oscillation influenced the drought variation in this region. The $PDSI_{5\text{-}7}$ reconstruction showed a long-term declining (dry) trend during the period of the 1950s–2010s. This drying trend was also detected in the PDSI data of other parts of China after the 1950s. We believe that these phenomena may be related to a large extent with the weakening of the East Asian summer monsoon.

TN – PO01: Evaluation of tree growth relevant atmospheric circulation patterns for geopotential height field reconstructions for Asia

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Atmospheric circulations influence local and regional weather conditions and, thus, tree growth. To identify summer weather types relevant for tree growth, and their associated synoptic-scale circulation patterns, an atmospheric circulation tree ring index (ACTI) dataset, derived from 414 tree-ring sites across Asia spanning the period 1871–2010, was created. Modes of common variability in the ACTI dataset were compared with leading modes of observed summertime 500-hPa geopotential height. The first four ACTI modes (explaining 88% of the total variance) were associated with pressure centers over Eurasia, the tropics, and the Pacific Ocean. The high spatiotemporal resemblance between the leading circulation modes, derived from both tree rings and 500-hPa geopotential height fields, indicates a strong potential for reconstructing large-scale circulation patterns from tree rings in Asia. This would allow investigations of natural atmospheric circulation variability prior to anthropogenic climate change and provide a means to validate model simulations of climate predictions.

TN – PO02: Development of a tree-ring $\delta^{18}O$ network for Japan, Taiwan and Korea as a tool to date wooden materials

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Tree-ring $\delta^{18}O$ records have been rapidly developed from monsoon Asia over the last decade, especially focusing on hydroclimate reconstructions over the past several centuries. Since the tree-ring oxygen isotope ratios are mainly controlled by two climatic factors (i.e., relative humidity and $\delta^{18}O$ of precipitation) and are less influenced by ecological conditions, tree-ring $\delta^{18}O$ chronologies are significantly correlated with each other, even though those sites are more than 1000 km distant from each other. Therefore, tree-ring $\delta^{18}O$ records can also be used to precisely date wooden materials collected from archaeological sites and old buildings. Here we developed tree-ring oxygen isotope chronologies from Japan, Taiwan and Korea, and used these records to explore potential for dating wooden materials collected from multiple sites in Korea and Japan. While tree-ring $\delta^{18}O$ chronologies developed in the present study originated in Japan, Taiwan, and Korea, overall those were significantly correlated with each other. More specifically, the correlations of tree-ring $\delta^{18}O$ records were usually stronger between the sites located in similar latitude than between those in similar longitude, indicating that Meiyu-Baiu frontal activity in early summer plays an important role in modulating such spatial correlations of tree-ring chronologies. Using our multi-millennial long chronologies developed from Japan, we successfully dated wooden materials collected not only from Japan but also from Korea. We conclude that the tree-ring $\delta^{18}O$ network has great potential to date wooden materials collected from regions where local tree-ring records have not yet been developed.

EA – OR01: Breaking news for dendrochemistry: Nanoparticles enter into the wood through leaves.

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Dendrochemical studies, i.e., including the analysis of the chemical composition of tree-ring wood, focused in the 1980s on the impact of acidic rain on forest ecosystems and the role that pollutants were playing in forest decline. From these studies, we learned that heavy metals, if not bound in the soil, enter into the wood through root uptake.

Although it has been shown that nanoparticles adsorbed to plant surfaces may penetrate into leaves via stomata, significant long-distance translocation of nanoparticles through the phloem and their accumulation in tree rings has never been demonstrated and is still believed to be impossible.

In this talk, we present case studies close to 1) a highway in Switzerland, 2) an asbestos factory, 3) a steel factory, 4) Mount Etna, an active stratovolcano in Italy, and 5) in an urban area in Xi'an, China. We investigated tree rings using stable isotopic (^{13}C, ^{18}O, ^{15}N) and radiocarbon (^{14}C) analyses, laser ablation inductively coupled plasma mass spectrometry, and chemical microanalysis and computer-tomography imaging at the synchrotron (Swiss Light Source, Villigen, Switzerland). We provide evidence that nanoparticles deposited on tree leaves are taken up through stomata and transported through the phloem into the xylem of trees. We found changes in tree-ring chemical composition related to changes in air quality, which enabled us to reconstruct past air pollution episodes and trends.

This discovery has tremendous consequences opening up new research avenues and opportunities i) in tree physiology, because particles pass through the cell membrane, ii) in urban forestry, to select the most appropriate tree species to take up particulate pollution, and iii) in monitoring spatio-temporal variability of air pollutants, extending the short current air quality records retrospectively. Tree rings – being investigated for the presence of nanoparticles – have a terrific potential to be used as archives of past environmental pollution.

EA – PO01: Crops yield in Khakassia (South Siberia): reconstruction based on low- and high-frequency components of tree-ring chronologies

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Interrelations of the yield variability of the main crops (wheat, barley, and oats) with hydrothermal regime and growth of conifer trees (*Pinus sylvestris* L. and *Larix sibirica* Ledeb.) in forest-steppes were investigated in Khakassia, South Siberia. An attempt has been made to understand the role and mechanisms of climatic impact on plant productivity. It was found that amongst variables describing moisture supply, wetness index had maximum impact. Strength of climatic response and correlations with tree growth are different for rain-fed and irrigated crops yield. Climatic influence on crops is observed from May to July, whereas conditions of previous vegetation season's end and cold season are also significant for conifer growth. Separated high-frequency variability components (first differences) of yield and tree-ring width have more pronounced relationships between each other and with climatic variables than their chronologies per se. Low-frequency variability components (series smoothed by 5-year moving average) of crops yield and tree growth are also strongly correlated, with maxima observed after 1 to 5 years time shift of tree-ring width chronologies. Results of analysis allowed us to develop original approach of crops yield dynamics reconstruction on the base of high-frequency variability component of the growth of pine and low-frequency one of larch.

FW – OR01: Reconstruction of the Holocene palaeoclimatic changes on the basis of subfossil peatland trees' dendrochronology and peat stratigraphy: the selected peatlands of the Southern, Central and Northern Poland

Włodzimierz Margielewski[1*], Marek Krąpiec[2], Katarzyna Korzeń[3], Elżbieta Szychowska-Krąpiec[2], Joanna Barniak[2], Monika Niska[4], Agata Wojtal[1], Renata Stachowicz-Rybka[5], Agnieszka Pociecha[1], Andrzej Obidowicz[5], Mirosława Kupryjanowicz[6], Magdalena Fiłoc[6], Krzysztof Buczek[1], Jan Urban[1], Aleksandra Rycerz[1]

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Dendrochronological analysis of subfossil pine trees buried in the peat of the Puœcizna Wielka raised bog (Polish Carpathians, Southern Poland), were compared with similar studies conducted in peatlands of Polish Uplands (Central Poland) and Lowlands (Northern Poland). Study in the Puœcizna Wielka bog indicates 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, 3940-3050 cal. BP, and since 2.6 ka cal BP. These deforestations were preceded by tree dying-off phases caused by the climate humidity growths and coolings. These climatic changes were reconstructed on the basis of dendrochronological analysis of trees, and as a multi proxy analysis and radiocarbon dating of peat sediments. Similar dying-off phases were dendro-chronologically detected ca 2.7 ka cal BP in the Rucianka peat bog in the Polish Lowlands (accumulated since ca 3.3 ka cal BP). Results of pine bog dendrochronology and peat analysis in the other peatlands of the Polish Lowlands: Budwity and Imszar petlands, and in the Polish Uplands: Napoleonów and Mosty peatlands, accumulated since ca 9.9-8.5 ka cal BP, allowed us to refer the tree dying-off episodes to the Late Atlantic/Early Subboreal (ca 5.9-5.6 cal ka BP – Imszar bog, death forest horizon exposed due the peat extraction), during the Late Subboreal/Early Subatlantic climate humidity growths at ca 3.7 ka cal BP in the Napoleonów, at ca 3.5 ka cal BP in Budwity (death forest horizon). The same episode in the Mosty peatland was estimated at ca 1.1 -1.2 ka cal BP. All the tree dying-off episodes, are well correlated with phases of climate humidity growths and coolings. The multi-proxy analysis of peat sediments and subfossil bog-pine trees are sensitive indicators of climate humidity fluctuations in the Polish territory during the Holocene.

This study was supported with funds from the National Science Centre (NCN) grant No. 2017/25/B/ST10/02439 (2018–2021).

FW – PO01: The bog pine dendrochronology related to peat stratigraphy - reconstruction of the Holocene palaeohydrological changes of the mountainous area: the Puœcizna Wielka raised bog, Polish Inner Carpathians, Southern Poland

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The Puœcizna Wielka raised bog (Polish Western Carpathians, Southern Poland) is the only currently known site with numerous subfossil pine trees in the mountainous regions of Central Europe. Dendrochronological analysis of these subfossil pine trees, as well as analysis of pollen and non-pollen palynomorph assemblages and radiocarbon dating of the peat deposits of this bog indicate that the majority of the tree populations grew in the peat bog during the periods ca 5415-3940 cal BP and 3050-2560 cal BP. Several forestless episodes, dated to 5245-5155 cal BP, 4525-4395 cal BP and 3940-3050 cal BP, were preceded by tree dying-off phases. These events were genetically connected by extreme increase in humidity and general climate coolings. In turn, the phases of germinations and tree and shrub invasions of the peat bog areas were closely connected to drying and repeated warming of the regional climate. These events and their reasons are consistent with the data obtained from dendrochronological and palynological studies carried out at other similar sites in Europe. The last forestless periods that started about 2600 years ago lasted to the very recent time. Recently, due to human activities causing a lowering of the groundwater level (owing to improved water drainage system) and – consequently - drying of the peat bog, pine trees have overgrown the peat bog again. The results of our study indicate that the multiproxy analysis of peat sediments and subfossil bog-pine can be effectively used for a reconstruction of climate humidity fluctuation that occurred within the Carpathian region during the Holocene.

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ADA-2019 – Quantitative Wood Anatomy Workshop

Session Instructor: Kambiz Pourtahmasi*

Department of Wood and Paper Science and Technology, Faculty of Natural Resources, University of Tehran, Karaj, Iran
**E-mail: Pourtahmasi@ut.ac.ir*

Topics to be covered:

- Wood formation studies (Dendrometer and micro coring)
- Wood formation measurements (Cambium activity and Cell differentiation)
- Measuring Wood Anatomy Parameters in Tree-Rings (Introduction to ImageJ)

ADA-2019 – Tree-ring and R Workshop

Session Instructor: Marcin Koprowski*

Nicolaus Copernicus University, Faculty of Biology and Environmental Protection, Department of Ecology and Biogeography, Torun, Poland
**E-mail: koper@umk.pl*

Topics to be covered:

- R and R-Studio background
- dplR R package
- bootRes/treeclim R packages

ADA-2019 – Dendrogeomorphology Workshop

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Topics to be covered:

- ***Module 1***: Introduction to dendrogeomorphology; Dating of various geomorphic processes (avalanches, rockfalls, debris flow, floods, landslides, erosion) recorded in trees for natural hazards and risk assessment; Limitation and future perspective of dendrogeomorphology.
- ***Module 2***: Sampling strategy for dendrogeomorphological study; Identification of injured trees and growth disturbances; Introduction to softwares – CooRecorder and CDendro; Practical exercises.
- ***Module 3***: Introduction of dendrogeophorphic reconstructions and its interpretation; Uses of R and MS-Excel for dendrogeophorphic reconstructions.

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