Asian Dendrochronology-Past and Present Experiences and Future Challenges

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The first Asian dendrochronology, September 2007
Asia consists of 32 countries; it is the world's largest and most populous continent, located primarily in the eastern and northern hemispheres. Asia covers 8.6% of the Earth's total surface area (or 29.9% of its land area) and with approximately 4 billion people, it hosts 60% of the world's current human population. The climate in Asia is very extremes.
Dendrochronology in Asia
Mongolia

Figure 1. Map of Mongolia showing Sol Dav tree-ring site (dot) and other locations mentioned in text.

Pederson et al reconstructed hydrology for northern Mongolia derived from tree ring: AD1651-1995 by using *Pinus sylvestris* and *Larix sibirica*.

China

The field of dendrochronological research has developed very rapidly in China. China encompasses a large land area characterized by multiple climatic zones. Chinese dendrochronologists have taken samples from areas as disparate as the lowlands and the highest and extreme climate condition of the Tibetan plateau. Related publications are increasing in frequency.
Yang et al. (2009) investigated the tree ring width of Tibetan juniper (*Cupressus gigantean*) from 1377-1998 AD (622-years)

Shao et al. (2009) investigated changes over a period of 3585 years in the ring width of juniper (*Juniperus przewalskii* Kom). This worked combined specimens from 22 archeological sites, 24 living tree sites, and five standing snags sites in the eastern and northern Qaidam Basin, northwestern China.
Tree-ring studies in Japan date back to the 1920s-1930s. In the beginning, authors studied *Castanea crenata*, Formosan cypress and *Cryptomeria japonica* and tried to correlate periodic variations in growth with historically documented alterations in climate.
In the early 1980s, Mitsutani at the National Cultural Property Research Institute in Nara started a research program to expand the study of dendrochronology in Japan. Most living species of Cryptomeria japonica, Chamaecyparis obtuse and Sciadopitys verticilata from central and western Japan were analyzed. Subsequently, many objects from the Nara museum were investigated using non-destructive techniques.
Sho et al. (2009) used tree ring width and stable carbon isotope composition of Japanese cypress to reconstruct a 300-year record of past hydrological and climatic environment in the Lake Biwa area, central Japan.

Yonenobo and Eckstein (2006) reported the results of dendroclimatic study in central Japan using tree ring width data from living Hinoki cypress. February-April temperature was reconstructed for the period 1719-1961 AD.
Korea is strongly affected by monsoons that come from the east. Most of the relevant dendrochronological research has been performed by Park won-Kyu.
**South Asia:** Dendrochronology research is quite active in India. Three institutional efforts are pursuing various aspects of tree ring studies. One led by Bhattacharaya, Yadov, Shah, and Singh from the Birbal Sahni Institute of Palaeobotany, Lucknow, India; one at the India institute of Tropical Meteorology, Pune/Maharashtra; and one at the Physical Research laboratory, Ahmadabad/Gujrat.
Species studied include the following: teak (*Tectona grandis*) and toon (*Cedrela toona*); several conifers in the Himalaya region (*Abies pindrow*, *Cedrus deodara*, *Picea smithiana*, *Pinus gerardiana*); species in semi-arid to arid regions in the western Himalayas such as pencil juniper (*Juniperus polycarpos*) and common yew (*Taxus baccata*).
Singh et al. (2009) presented a 694-year tree ring-based rainfall reconstruction based on data collected from Himachal Pradesh, India. They developed ring width indices of *Cedrus deodara* (Roxb.) G.Don and *Pinus gerardiana* (Wall.Ex.Lamb) . The authors reconstructed March-July precipitation from 1310-2004 AD.
Nepal: Tree ring width has been used for temperature reconstruction in the northernmost region of Nepal. To date, 12 reports have been published: seven on tree ring width chronology, four on tree ring width and densitometry, and one on archaeology. The species that cross-dated well in Nepal were as follows: *Abies spectabilis*, *Pinus roxburgii*, *Pinus wallichiana*, *Tsuga dumosa*, *Picea smithiana*, *Juniperus recurva*, *Ulnus wallichiana*, *Cedrus deodara* and *Larix potanini*. 
Pakistan by M. Ahmed established dendro lab in Pakistan in 2005, 7 species have been studied for dendrochronology so far. The longest pine index is 747 year.

Iran; identification of Iranian archeological woods by vessel shap; V. Safdari
Southeast Asia

Indonesia: Geiger (1915), Coster (1927, 1928), and Berlage (1931) conducted pioneering studies of 400-year-old teak tree rings in Indonesia, for comparison with climate data. D’Arrigo et al. (1994) established a 416-year (1514-1929) tree ring width chronology for teak (*Tectona grandis* L.F.) from Cepu, Central Java, Indonesia. The teak tree ring correlated positively with rainfall and inversely with sea level pressure during the dry monsoon (around May to October).
D’Arrigo et al. (2008) investigated the Java drought record using nine datasets collected for tree rings from Javan teak (*Tectona grandis*) and one dataset collected for coral. This Java reconstruction is most sensitive to adverse climatic events such as drought. D’Arrigo et al. (2009) also reconstructed stream flow for the Citarum River, Java, Indonesia. A tree ring-based reconstruction covered the period from 1759-2006 AD.
Vietnam: Tree ring based hydroclimate reconstruction was introduced by Sano et al. (2009) by using *Fokienia hodginsii*, rare and long-lived conifer, from northern Vietnam. Tree rings spanned the course of 535 years; this is the longest cross-dated tree ring series yet produced from continental Southeast Asia. The annual growth of *Fokienia* was mostly controlled by soil moisture in the pre-monsoon season. The reconstruction revealed two prominent periods of drought in the mid-eighteenth and late nineteenth centuries.
Cambodia: Buckley et al. (2009) used ring width records for the rare cypress *Fokienia hodginsii* growing at two sites in the highlands of Vietnam’s Bidoup Nui Ba national park. They reconstructed a 759-year history (1250-2008 AD) of the early monsoon (March-May) Palmer Drought Severity Index (PDSI). The reconstruction reveals weakened monsoons in the mid- to late fourteenth century; a short though at times more severe drought in the early fifteenth century coincided with Angkor’s eventual demise.
Laos: Buckley et al. (2007) investigated the growth rings of *Pinus merkusii* from Lao P.D.R. They used three parameters: tree ring width, early wood width and late wood width and examined the correlation with climate data from a composite of 13 nearby stations in Thailand. These three indices showed significant correlations with gridded sea surface temperature (SST) over the central and eastern tropical Pacific.
Thailand: Thammincha (1988) was the first to use pine tree rings to study the growth pattern of pine in northeast Thailand.

Pumijumnnong et al. (1995) established a teak tree ring study in northern Thailand.

Buckley et al. (2008) conducted a successful study of teak in Mae Hong Son province, northwestern Thailand. The authors identified a 448-year teak chronology that indicated the importance of summer monsoons.
In addition to tree ring width, vessel diameter has been used in teak to identify any correlation with climatic data (Pumijumnong and Park 1999).

Pumijumnong et al. (2001) presented the first teak tree ring chronologies in Myanmar.

The results of such analysis elucidate the frequency of teak log coffin use and inform archaeologists with regard to previously used woodcraft techniques (Pumijumnong et al. 2007).
Buckley et al. (1995) established four pine chronologies for *Pinus kesiya* and *P. merkusii* from northern, D’Arrigo et al. (1997)

Linasmita (2004) studied cambium activity of *pinus kesiya*

A. marina
In conclusion, dendrochronological research is well established in Asia. Dendrochronological techniques have been using to explore paleoclimate and patterns of tree growth. To this end, various techniques have been applied, from the traditional tree ring technique to complicated and highly technical variations. Because this endeavor is just beginning in certain countries in Asia, academic conferences dedicated to dendrochronology will be necessary to transfer knowledge, connect like-minded researchers and facilitate further research.
Particularly in Thailand, dendrochronology has the potential to inform related fields such as archaeology or dendroecology (e.g., in the case of an insect outbreak in a teak forest). Teak is of particular interest in the field of dendrochronology; other species may become more informative with the development of novel techniques, such as methods to analyze cambium activity, tree physiology and isotope.