



# Tree-ring analysis of Tropical Indian tree with special emphasis on *Tectona grandis* and *Cedrela toona*.

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## ABSTRACT

Several tropical trees of India are known to produce growth rings (Gamble, 1902; Chowdhary, 1939). But except Teak (*Tectona grandis*) and Toon (*Cedrela toona*) datability of these rings to the exact year of their formation, which is a prerequisite for the tree-ring analyses, is yet to be established in these trees. The present study is an attempt to explore the potentiality of tropical trees with emphasis to Teak and Toon in dendroclimatic research. In the present study Teak has been analyzed from two sites of peninsular region of India and is recorded more suitable for dendroclimatic analysis than toon, latter has been studied from Kalimpong subdivision, Eastern Himalaya. Teak chronology from Kerala extends from A.D 1590-2000 (411 years) and Madhya Pradesh extends from A.D 1836-1997 (162 years). Teak tree exhibits positive relationship with precipitation of current year's June to October in Hoshangabad and with precipitation of current year's May and August in Perambikulam. Positive relationship with precipitation of monsoon months suggests that early SW monsoon precipitation play an important role in the growth of Teak. For Toon, a 180-year (AD 1824-2003) ring-width chronology of this tree has been prepared. Tree ring data of Toon exhibit positive relationship to precipitation of current's year June.

## MATERIAL AND METHODS

### Tree-ring Sampling sites:

Tree ring samples were collected from three sites under moist deciduous forests. Teak were collected from two sites viz., Hoshangabad (77°7' and 78°44' E Long and 22°17' and 22°50' N Lat) in central part of India and Perambikulam (76.35' and 76°50' E. long. and 10°20' and 10°26' N. lat.) Southern part of India. Samples for Toon were collected from one site, Lava (88°8' E long, and 27°3' N Lat), Kalimpong subdivision of Darjeeling, Eastern Himalaya. Samples are either in the form of core, which are collected through Increment borer from living trees both Teak and Toon, or disc collected from the left over stumps or logged Teak trees.

### Sample Processing:

The surfaces of the entire Teak disc were made smooth by using sanding machine. Rings were later examined and widths of these rings along 3-4 radii or directions of each disc (from center towards bark) were counted and measured with a magnifying glass calibrated with scale to nearest tenth of a millimeter.

Core samples were mounted in the grooved wooden blocks with the transverse surface of the core upwards. After that cores were cut by the sharp razor blade and polished with the help of different grades of sandpaper so that the rings get clearly visible to analyze under microscope

### Acquisition of tree ring data & chronology development:

The dates of each ring were determined by matching the ring-width patterns through cross-dating technique. A computer program COFECHA was used to check both the error and also verifying the dates

Ring-width data were standardized to form tree ring indices using computer program AutoRegressive STANdardization (ARSTAN).

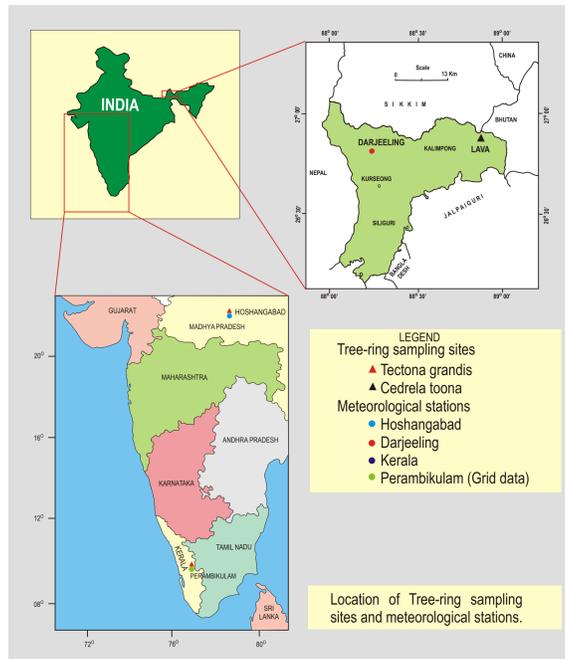
The length of each chronologies prepared are:

Teak chronology from Perambikulam Kerala extends from A.D 1590-2000 (411 years) and Hoshangabad; Madhya Pradesh extends from A.D 1836-1997 (162 years)

Toon chronology from Lava extends from A.D. 1824-2003 (182 years).

Some of the selected statistics considered for the evaluation of tree ring chronology are shown here:

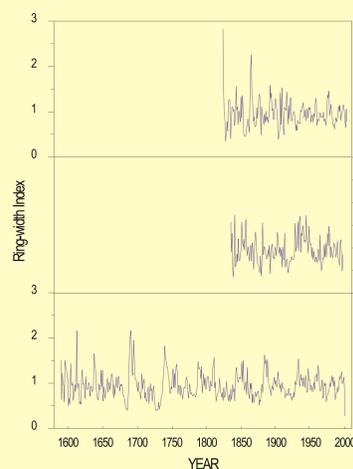
	TEAK ( <i>Tectona grandis</i> )		TOON ( <i>Cedrela toona</i> )
	Perambikulam	Hoshangabad	Lava
Chronology Time Span:	A.D.1590-2000	A.D.1835-1997	A.D.1824-2003
Number of Tree (radii):	53 (89)	21 (50)	13 (34)
Mean sensitivity:	.1916	.2710	.2348
Standard deviation:	.2764	.2891	.3125
Autocorrelation order 1:	.2764	.2947	.3923
Common Interval:	A.D. 1822-1918	A.D. 1909-1997	A.D. 1948-1993
No of Tree (radii):	32 (46)	17 (40)	9 (12)
Correlation between trees:	.217	.202	.176
Correlation within trees:	.479	.661	.227
Signal-to-noise ratio:	8.894	4.308	1.925
Expressed population Signal	.899	.812	.658
% Variance Explained:	26.44%	29.31%	26.47%



One of the Toon (*Cedrela toona*) trees sampled. These trees have many buttresses. This makes them less desirable for collecting samples



Collection of Teak (*Tectona grandis*) samples (discs) from left over Teak stumps at



Tree-ring chronologies of Teak and Toon  
 (a) Tree-ring chronology of Teak from Perambikulam extending from A.D. 1590-2000.  
 (b) Tree-ring chronology of Teak from Hoshangabad extending from A.D. 1836-1997.  
 (c) Toon-ring chronology of Teak from Lava extending from A.D. 1824-2003.

## FUTURE DIRECTIONS

Tropical broad-leaved taxa need to be analysed from diversified geographical regions to optimized suitable sites and trees for a network long climatic sensitive tree ring chronology for reconstruction of climate.

Emphasis for the good replication tree-ring samples of both the species from homogeneous sites to enhance climatic signals.

To explore any possible relationship global parameters such as Little Ice Age, ENSO, El Niño and Global Warming with Teak chronology.

An integrated approach is needed to protect the rapidly vanishing resources by declaring old trees at some forest sites as national heritage which ensure their protection and such trees could provide high resolution palaeoclimatic information for several centuries.

## BACKGROUND OF THE PRESENT STUDY

"Dendroclimatology" deals with the analysis of precisely dated tree ring series to produce accurate and quantitative information about past climatic changes and variability. In most of the tree ring /climate reconstructions, from mountainous or high latitude sites conifers have been widely used. However, to build up the detailed global climatic scenario emphasis is needed on broad-leaved tropical trees, which occupy the major part of lower latitude sites. India for its diversified tropical trees under varied ecological conditions seems to be one of the promising regions, which would ensue a variety of potential trees for such analysis. So far, expect some exploratory analyses (Pant and Borgaonkar, 1983; Bhattacharyya et al, 1992; Yadav and Bhattacharyya, 1996) detailed tree ring study from broad-leaved taxa yet to come. The present study exhibits dendroclimatological prospect of two broad-leaved taxa viz., Teak (*Tectona grandis*) and Toon (*Cedrela toona*) growing in different geographical location.

## TREE-GROWTH/CLIMATIC RELATIONSHIP

Significant climatic variables limiting growth of both Teak and Toon tree in these regions were determined using response function analysis based on orthogonal bootstrap regression (Guiot, 1991) on residual chronologies. A 17-month dendroclimatic year starting from August of the prior growth year to the December of the current growth year was used to in case of Teak and 14-month dendroclimatic year starting from September of the prior growth year to the October of the current growth year was used to in case of Toon.

### Teak in Hoshangabad:

The analysis shows that the precipitation of current year's June-October have significant positive response where as January and May precipitation of the current year has negative relationship on the growth of Teak in this region.

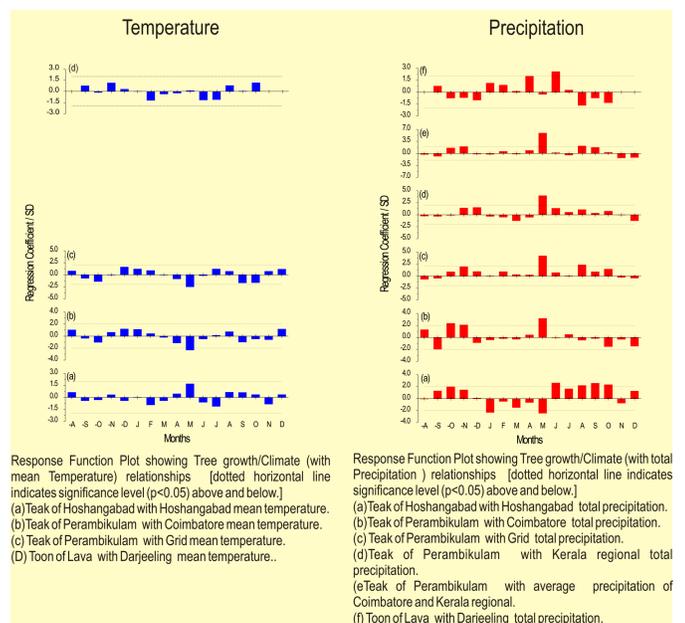
### Teak in Perambikulam:

Due to the unavailability of the climatic data specific to studied site Tree-growth Climate relationship was determined with the climatic data of Coimbatore, Kerala regional Precipitation and Grid data of IPCC.

The analysis shows the current year's precipitation of May and August have significant positive response on the growth of Teak in this region.

### Toon in Lava:

The analysis shows that the precipitation of current year's June has significant positive response on the growth of Toon in this region.



Response Function Plot showing Tree growth/Climate (with mean Temperature) relationships [dotted horizontal line indicates significance level (p<0.05) above and below.]  
 (a) Teak of Hoshangabad with Hoshangabad mean temperature.  
 (b) Teak of Perambikulam with Coimbatore mean temperature.  
 (c) Teak of Perambikulam with Grid mean temperature.  
 (d) Toon of Lava with Darjeeling mean temperature.  
 (e) Teak of Perambikulam with average precipitation of Coimbatore and Kerala regional.  
 (f) Toon of Lava with Darjeeling total precipitation.

## IMPORTANT GOALS ACHIEVED

Established the fact that Tree-ring studies from the Tropical broad-leaved taxa have got potentiality of dendroclimatology analysis.

Precipitation influences the tree growth of both the broad-leaved taxa.

The Teak growth/climate relationship from Peninsular India indicate the potentiality of the species in reconstructing the past vagaries of monsoon and drought/flood events.