TREE GROWTH/GLACIER/CLIMATE RELATIONSHIP IN THE HIMALAYAN REGION AND ITS IMPORTANCE IN THE UNDERSTANDING OF HYDROLOGICAL RESPONSES

AMALAVA BHATTACHARYA AND RAM R. YADAV
Birbal Sahni Institute of Palaeobotany, 53 University Road,
Lucknow 226001, India

A variety of conifer species, having distinct datable annual rings, are found throughout the Himalayan region extending from northwest Kashmir to southeast Sikkim. Tree ring samples of many of these species, viz *Pinus gerardiana, P. roxburghii, P. wallichiana, Cedrus deodara, Taxus baccata, Abies pindrow, A. spectabilis, Picea smithiana, Tsuga dumosa,* and *Larix griffithiana,* have been studied to develop long tree ring chronologies to understand various changing environmental parametres in time and space. To maximise the climate signal in tree rings and avoid cases where that signal has been disrupted by human or other natural disturbances, utmost care has been taken in the selection of sites, species, and even individual trees. Several tree ring chronologies have been prepared by using ring width data. These regional chronologies are expected to reveal information on global climate phenomena such as the Medieval Warm Period and Little Ice Age.

To understand the effect of environmental factors, especially of temperature and precipitation on tree growth, response function analyses have been carried out with different chronologies using climate data of meteorological stations close to the sampling sites. The response function study involved the regression of principal components of the monthly temperature and precipitation data on the annual tree ring indices to derive a set of regression coefficients that indicate the direction and relative strength of the impact of monthly data on tree growth.

The response function analysis of *Pinus gerardiana* from Kinnaur in the northwest Himalaya shows that precipitation of previous year's October and December and current year's January and July plays an important role in tree growth. Tree ring chronologies extending back 500 years have been prepared for this species and would be very useful in the reconstruction of winter precipitation. Around 400 years' chronology of *Pinus wallichiana* has also been prepared from the same area. The tree growth in this case is closely related to the precipitation of previous year's October and February, and March of the growth year. A comparative study of tree ring data with glacial mass balance has also shown poor tree growth during the positive mass balance years. *Deodar* (*Cedrus deodara*) growing in diverse ecological conditions has been found to provide ideal tree ring material for developing very long chronologies in India. The longest chronology constructed so far from the Indian region extends back to 1243 AD. Tree ring chronologies of this species, prepared from the moisture-stressed site in the western Himalaya, show the strong signature of the precipitation of March, April of the growing year, and October of the previous year.

Tree ring chronologies from the eastern Himalayan region in India were taken up very recently. The study has shown the prospect for developing several centuries long chronologies.

Tree ring chronologies of *Cedrus deodara* from Nepal, with excellent internal dating, show strong common signals. Very long tree ring chronologies of *Tsuga dumosa* (1569-1978 AD) and *Abies spectabilis* (1607-1978 AD) have also been prepared for climatic studies from Nepal.

The tree ring studies so far, conducted from diverse climatic zones of the Himalayan region, reflect strong signatures of climatic conditions, such as fluctuations in temperature, precipitation, glacier mass balance, and glacial fluctuations. Long, well-replicated tree ring chronologies seem to be very useful in the reconstruction of variations in temperature, precipitation, and water budgets of major rivers originating from the Himalayas.