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Pinus roxburghii stand dynamics at a heavily impacted site in Nepal: Research through an educational fieldweek☆

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ABSTRACT

The fieldweek associated with the 4th Asian Dendrochronological Association Conference was an excellent opportunity for education, networking, and research. The participants and group leaders worked together for five days in an area that was new to some of the group leaders and new to some of the participants which enabled us to learn about forest ecology around Kathmandu and Nagarkot, Nepal. The fieldweek was an excellent networking opportunity and the group leaders and participants bonded which strengthened international research in dendrochronology and continues to foster new research collaborations. All of the group leaders and participants had the opportunity to learn about tree-ring

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Experiential learning
Anthropogenic impact

formation in *Pinus roxburghii* at 1500 masl elevation, to explore its wood anatomy, and to examine specific research questions in our field area. In the end we developed a better understanding of the stand-age structure of a stand of trees in Nagarkot, explored the erosion history from exposed roots, and investigated tree health issues on closely related sites. We found that *P. roxburghii* poses some dating issues with false and micro rings at this elevation, but we were still able to develop a tree-ring chronology from this species and make preliminary assessments of stand dynamics and health.

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1. Introduction

From March 4th through March 8th, 2015 we participated in a dendrochronology fieldweek (Fig. 1) associated with the 4th Asian Dendrochronological Association (Cherubini, 2015) conference in Kathmandu, Nepal similar to the fieldweek reported on in Idaho, USA in 2005 (Speer, 2006) and in Segovia Spain in 2012 (Touchan et al., 2013). During this fieldweek instructors from the USA, Germany, and China gave lectures and lead groups sampling *Pinus roxburghii* to examine stand-age structure and disturbance history, dendrogeomorphology through soil erosion and root exposure, and tree health, respectively. This fieldweek was organized as a hands-on training session for 26 individuals from seven countries: Bangladesh, Bhutan, India, Mongolia, Myanmar, Nepal, and Zambia. This fieldweek was intended to be a basic introduction to the practical methods of dendrochronology. Besides lectures from the instructors, the participants had the opportunity to take increment cores, mount all of their samples, sand them with a belt sander, work through multiple cross-dating techniques, practice COFECHA (Version 6.06, Holmes, 1983; Grissino-Mayer, 2001) and ARSTAN (Cook and Holmes, 1986; Cook and Krusic, 2005; LDEO, 2015), conduct some project specific analyses, and finally to present their results at the end of the fieldweek. The purpose was to provide all of the basic dendrochronological methods for a research project throughout a complete project so that they could apply this type of analysis on their own sites.

1.1. Dendrochronological studies in Nepal

Nepal, due to its wide geographical variation and associated climatic condition, has good potential for dendrochronological research. However, this type of research does not have a very long history in Nepal and was started much later compared to other countries. According to Bhattacharyya et al. (1992), earlier tree-ring collections in Nepal were initiated in the late-1970s (1979–1980) by Rudolf Zuber who examined a diversity of tree species. Bhattacharyya et al. (1992) elaborated on this previous dendrochronological research in Nepal by doing broad scale sampling and described 10 ring-width based chronologies and discussed the prospects for further dendroclimatic work in Nepal. Later, researchers from USA led by Dr. Ed Cook at Lamont-Doherty Earth Observatory with Columbia University continued to enhance dendroclimatic research. They carried out extensive sampling in Nepal and developed 32 tree-ring chronologies using diverse tree species (Cook et al., 2003). Though the involvement of Nepalese researchers in this field was started at the end of the 20th century (Regmi, 1998), it has been increasing rapidly since 2009 after the establishment of first institutional Tree-Ring Lab on the premises of the Nepal Academy of Science and Technology (Fig. 2, Gaire et al., 2013). Most of the studies have used ring-width parameter for past dendrochronological studies in Nepal. Some studies (Kobayashi et al., 2002; Sano et al., 2002a,b, 2005; Bräuning, 2004) have used wood densitometry (X-ray densitometry) technique and only two studies (Sano et al., 2010, 2012) have analyzed stable isotope in tree rings for the study of past climate change in Nepal.

Dendrochronological studies from Nepal have been conducted over much of the Nepalese Himalaya (Fig. 2). These studies covered more than 25 districts of Nepal. Elevation range of these studies is from below 1000 m to 4300 masl. Tree-ring studies in the Nepal Himalaya region have been restricted to the lower temperate and sub alpine forests (e.g., Suzuki, 1990; Bhattacharyya et al., 1992; Cook et al., 2003; Bräuning, 2004; Sano et al., 2005; Chhetri and Thapa, 2010; Ghimire, 2012; Thapa et al., 2014); However, some tree-ring studies are found from the treeline of Nepal Himalaya (e.g., Bhuju and Gaire, 2010; Gaire et al., 2011, 2014; Shrestha, 2012) and subtropical region (Regmi, 1998). Many studies are concentrated in only a few areas like Langtang, Khumbu, Mustang, and Manaslu (Gaire et al., 2013) so more work needs to be done to increase the spatial coverage of tree-ring studies in Nepal.

Dendrochronological studies from Nepal have examined more than 20 species including *Abies spectabilis, Abies pindrow, Acer* sp., *Alnus nepalensis, Betula utilis, Castanopsis indica, Cedrus deodara, Hippophae salicifolia, Hippophae tibetana, Juniperus indica, Juniperus recurva, Larix potaninni, Larix griffithiana, Neolitsea palens, Picea smithiana, P. roxburghii, Pinus wallichiana, Rhododendron campanulatum, R. arboreum, Schima wallichi, Sorbus* sp., *Tsuga dumosa,* and *Ulmus wallichiana*. Most of these tree species are coniferous; only a few studies are found in broad leaved trees like *Alnus*, *Betula*, *Castanopsis*, and *Rhododendron*. The most studied species is the fir tree *A. spectabilis*. In Nepal, there are several other tree and shrub species which have been included in the potential species list for dendroclimatic study (Speer, 2010) and several species need to be explored to test their potential. The length of the longest master ring-width chronology has been developed from *T. dumosa* which is 1141 years long extending from AD 856–1996 (Cook et al., 2003). A *B. utilis* chronology has been developed that is 457 years long extending from AD 1552–2009 (Dawadi et al., 2013) and is the longest in the world for that species. In spite of the distribution of Himalayan Birch in the high elevation, Liang et al. (2014) from the Nepal Himalaya showed that the growth of this species is strongly controlled by the precipitation and very sensitive to drought. Recently Liang et al. (2015) reported that not only the trees but also *Cassiope fastigiata* dwarf shrubs at high elevations of Himalayas are also indicators of climate change and important species for the dendroecological studies.

P. roxburghii is a common species in the Himalaya and has been previously examined for dendrochronological potential in only a few studies (Bhattacharyya et al., 1992; Borgaonkar et al., 1999; Ahmed et al., 2009; Brown et al., 2011). It occurs at a wide range of elevations from 450–2300 masl elevation and has been documented to form false rings (Brown et al., 2011). Our field site was located in Sallaghari, Nagarkot (Bhaktapur district, Nepal) on a site at 1500 masl elevation that experiences heavy anthropogenic disturbance as a picnic area that includes vehicle traffic through the forest stand (Fig. 2).

1.2. Objectives

Our main objective was to teach the basics of dendrochronology and to apply this knowledge to some selected research questions.

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