

## 1. Background:

Mountain forests are rich repositories of biodiversity. However as observed in other parts of world, the mountain forests are now increasingly degraded as a result of unsustainable agricultural and forestry practices.

A key to maintain these precious resources is to carefully manage them by having management plans based on proper resource assessment and volume increments derived from growth models.

The purpose of the paper is to: (i) assess the forest dynamics of the broadleaved forest ecosystems through forest inventory and (ii) understand the forest increment rates through study of growth rates of individual trees.



**Broadleaf forests in the study area**

## 3. Methodology:

For each increment core samples extracted, we measured the annual radial increment for the last 10 years to 0.001 mm precision using a Velmex TA measuring system (Velmex Inc. Bloomfield, New York).

We used the available information of current Dbh, diameter increment ( $i_d$ ) and past  $Dbh_i$  to calculate the periodic mean basal area increments for the last five years (equation 1).

$$BAI_i = \left[ \frac{\pi}{4} \frac{(2 \cdot Dbh_i \cdot i_d + i_d^2)}{5} \right] \quad (1)$$

where  $BAI_i$  is the annual basal area increment ( $cm^2$  /year),  $Dbh_i$  is the Dbh at beginning of the five year growing period in cm and  $i_d$  is the five year diameter increment in cm.



**Glimpses of the field data collection**

**Map of the study area along with inventory plots**

## 2. Study area and design

The data for this study come from a watershed in Dagana, a district in the south central part of Bhutan. We established 96 inventory points in a systematic grid of 800 m by 800 m covering an area of 6423 hectares of broadleaved forests.

Parameters such as dbh, tree height, horizontal distance from the center, azimuth were collected for every tree and sapling for understanding the stand information.

In every plot, we selected the tree with the median Dbh for every species to extract the increment cores. Two increment cores were extracted from each tree at 1.37 m height from ground level, with the first coring being on the side of the tree facing plot center and the second one on the opposite side.

## 4. Results and Conclusion

A total of 140 plant species was recorded indicating rich diversity of the watershed.

The total mean basal area increment for the 2004-2008 and 2009-2014 were  $3.13 \pm 3.34 m^2$  and  $3.74 \pm 4.06 m^2$  respectively. The annual increment for the last 10 years was  $0.69 m^2$ .

The understanding of the forest dynamics and information of the forest increment rates will improve the sustainable forest management and avoid exploitation of the resources.

However for predicting tree growth, we recommend calibrating increment models for the broadleaved forest of Bhutan (equation 2):

$$BAI = \exp \left( a + b_i \times (Treesize) + c_i \times (Comp) + d_i \times (Site) \right) \quad (2)$$

We recommend grouping of the species and then developing individual tree increment models for the groups.

<sup>1</sup>Institute of Silviculture, University of Natural Resources and Life Sciences, Peter-Jordan-Str.82, A-1190, Vienna, Austria

<sup>2</sup>Department of Forests & Park Services, Ministry of Agriculture & Forests, Thimphu, Bhutan