On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

Quantifying the Above-Ground Tree Carbon of Bhutan

Through "Allometric Equation Development"

ABSTRACT

- A biomass equation was used to quantify the total above-ground tree carbon in Bhutan.
- Biomass was sampled from four identified zones, with at least 32 trees per species.
- Currently, 20 biomass equations have been developed, with eight conifer species, 10 broad-leaved species, and two general equations.
- The target is to develop equations for 50 tree species in Bhutan.

BACKGROUND

- The development of above-ground tree biomass equations started in 2014 by the Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER), then Renewable Natural Resources Research Development Center (RNR–RDC) Yusipang, in collaboration with the Forest Resources Management Division (FRMD), the Department of Forest and Park Services (DoFPS), and the Ministry of Agriculture and Forests (MoAF).
- Randomized branch sampling and systematic bole sampling were applied, and sampling was carried out from four physiographic zones.
- The data was analysed and modeled with R under the guidance of Professor Timothy G. Gregoire at the Yale School of Forestry and Environmental Studies.

OBJECTIVES

- To develop species-specific allometric biomass equation of prioritized tree species of Bhutan to estimate the above-ground biomass and forest carbon

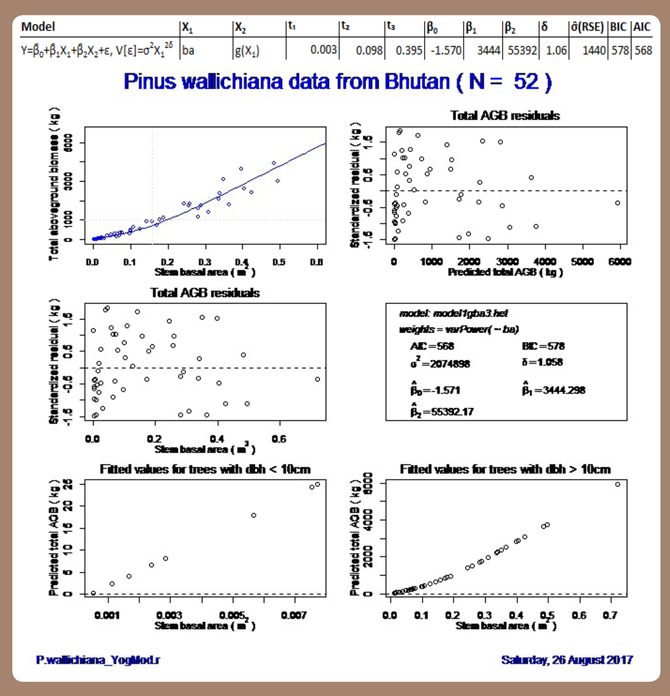
FUNDING SUPPORT

- The Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU), Germany and the Deutsche Gesellschaft für Internationale Zusammenarbeit–International Centre for Integrated Mountain Development (GIZ–ICIMOD) through the REDD+ Himalaya project.
- The Bhutan Reducing Emissions from Deforestation and Forest Degradation (REDD) Readiness Preparation Project, supported by the Forest Carbon Partnership Facility (FCPF) of the World Bank.
- The Bhutan Trust Fund for Environment Conservation.
- The UN–REDD Targeted Support through the UN Food and Agriculture Organization (FAO).

TOOLS AND EQUIPMENT

METHODS

- Identify physiographic zones.
- Identify trees by diameter class as required.
- Extract samples using randomized branch sampling (RBS) techniques.
- Tag and transport samples to laboratory for drying.
- Dry samples at optimum temperatures until they reach a constant weight.
- Compute the samples and estimate the overall dry weight of the tree.
- Carry out regression analysis to develop an equation.
- Identify the best-fitting regression model.



1. Measure DBH

2. Fell

3. Measure and sample

4. Sample bole disc

5. Measure sample dimensions

6. Pack and tag samples

7. Pathway samples

8. Transport samples to laboratory

9. Dry samples in the oven

RESULTS

Eighteen species-specific biomass models and two mixed-species models were developed of the model form:

$$Y = \beta 0+\beta 1X1+ \beta 2X2+\varepsilon,\ V[\varepsilon] = \sigma 2X12\sigma$$

BIOMASS FIELD CREWS

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