Proceedings on training on the development of a common allometric equation for hill zone

Bangladesh Forest Department
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The Forest Department of Bangladesh leads actions to improve forest management and conservation, adopting forward thinking, innovative approaches in its management of approximately 1.55 million hectares of land across the country.

In 2015, the Forest Department began a process to establish a National Forest Inventory and Satellite Land Monitoring System for improved forest and natural resource management. The process supports national objectives related to climate change mitigation and provides information in support of the UN REDD programme aimed at Reducing Emissions from Deforestation and Forest Degradation (REDD+). The process also addresses domestic information needs and supports national policy processes related to forests and the multitude of interconnected human and environmental systems that forests support.

The activities implemented under the Bangladesh Forest Inventory process are collaboration between several national and international institutions and stakeholders. National partners from multiple government departments and agencies assist in providing a nationally coordinated approach to land management. International partners, including the United Stated Agency for International Development (USAID), the Food and Agriculture Organization of the United Nations (FAO) and SilvaCarbon are supporting the development of technical and financial resources that will assist in institutionalising the process.

The results will allow the Forest Department to provide regular, updated information about the status of trees and forests for a multitude of purposes including for assessment of role of trees for firewood, medicines, timber, climate change mitigation.

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Executive Summary

A 22-day (04-25 March 2018) training is organised on strengthening the capacities for data collection using semi-destructive method for common allometric equation development for hill zone. The support was provided by FAO under a project titled "Strengthening National Forest Inventory and Satellite Land Monitoring System in support of REDD+ in Bangladesh" of Bangladesh Forest Department. The aim is to develop common allometric equation for hill zone in order to assess biomass and volume from tree data collected under the Bangladesh Forest Inventory. The specific objectives of the training were to develop stakeholder's capacity on data collection for allometric equation development and develop biomass expansion factors for selected tree species in order to convert the existing volume data of the respective species to biomass. Total four (male) participants have attended the training.

Potential locations across the hill zone including Khadimnagar National Parks, Lawachara National Park and Satchari National Park of Sylhet region as well as Chunati Wildlife Sanctuary, Fasiakhali Wildlife Sanctuary, Bomo Reserve Forest, Kaptai National Park and Dudhpukuria-Dhopachari Wildlife Sanctuary of Chittagong region were surveyed for data collection.

A total of 179 individuals from 15 species were sampled. Each sample tree is divided into sections from bottom to 10 cm diameter height point. For each section length and diameter at both end was measured. Besides, sub-samples of tree components i.e. leaf containing small branch, small branch and bark were collected for oven dry weight, wood density and carbon content. After coding, the samples were then sent to Khulna University for laboratory analysis. This training contributed to develop the capacities on data collection for allometric equation development and strengthen collaboration between national experts and universities.

1.   Introduction

The second session data collection of Bangladesh Forest Inventory that started in November 2016 under a project titled "Strengthening National Forest Inventory and Satellite Land Monitoring System in support of REDD+ in Bangladesh" of Forest Department, is going on. The tree data will be analysed mainly for assessing biomass, carbon and volume. Allometric equations are the key requirements for assessment of these parameters. Allometric equations at different levels i.e. species, genus, region and pantropical exists at varying numbers. There are 222 verified allometric equations in Bangladesh covering 39 species of trees, shrubs and bamboos (Mahmood *et al*. 2006). But, Bangladesh National Forest Inventory already recorded more than 280 tree species. Considering the time and scope, it is not feasible to develop allometric equation for all tree species. So, for having better estimate of both biomass and volume, initiative was taken for developing zone specific allometric equation. This training is designed for the collection of data using semi destructive method for the development common allometric equation for hill zone of Bangladesh.

This is worth to mention here that Bangladesh Forest Research Institute (BFRI) has developed some volume and biomass equations through destructive method of data collection. A list of 11 species that previously sampled for volume equation development by BFRI was prepared for field data collection (Table 1). Diameter and length of tree sections up to merchantable height (10 cm diameter height point) of those trees are available. So, the plan is to develop biomass expansion factor in addition to measurement and sub-sampling the tree part's (leaf, leaf containing small branch and small branches). With the biomass expansion factors, the existing volume data will be processed for biomass calculation of the respective species.

Table 1: List of tree species selected for data collection for allometric equation development in hill zone

Sl. No.	Species Name	Scientific name
1	Teak	*Tectona grandis*
2	Garjon	*Dipterocarpus turbinatus*
3	Dhakijam	*Syzygium grande*
4	Rubber	*Hevea brasiliensis*
5	Jarul	*Lagerstroemia speciosa*
6	Koroi	*Albizia* spp.
7	Bahera	*Terminalia bellirica*
8	Knank	*Pterospermum acerifolium*
9	Shimul	*Bombax ceiba*
10	Eucalyptus	*Eucalyptus* spp.
11	Minjiri	*Cassia siamea*

2.   Objectives

The general objective of this training was to strengthen the national capacities for data collection using semi-destructive method for common allometric equation development for hill zone.

The specific objectives were as follow:
- Select the sample trees from different diameter classes.
- Collect data for common allometric equation development from different tree sections and prepare sub-samples for laboratory analysis.
- Provide recommendations to improve the data collection process to develop allometric equation following this method in future.

3.   A brief description of the training program

The training involved 4 Masters students from the Institute of Forestry and Environmental Sciences Chittagong University and Shahjalal University of Science and Technology. The training also involved 2 resource persons from BFRI and Khulna University. Local labours (4-5 labours as per necessity) were appointed during data collection process to help sampling the targeted trees. Necessary logistics (**Table 2**) were ensured by the project for data collection from different locations of the hill zone.

Table 2: List of equipment used in the training program for data collection

Equipment used during the survey	
- GPS - Measuring tape (1 cm precision) - Diameter measuring tape (1 mm precision) - Suunto clinometer - Crosscut saw - Rope - Pruning scissor - Digital hanging or benchtop measuring scale 200-500 kg (0.1 kg precision)	- Digital laboratory balance 2200 g (0.01 g precision) - Zip poly bag - Woven polypropylene bag - Permanent marker - Pen and pencil - Field and laboratory data collection tables/ sheets - Clipboard - Large tarpaulins - Chopper

The training program is inaugurated at 9.30 am on 4 March 2018 in the BFI headquarter, Bana Bhaban, Agargao, Dhaka. On the same day the team including the participants and resource persons started their journey towards Sylhet region for data collection. On the following day, the team started sampling the pre-listed trees in Khadimnagar National Parks. Besides, trees were sampled from Lawachara National Park and Satchari National Park in the Sylhet region. On 13 March the team moved to Chittagong region for data collection in the remaining hill zone and continued up to the end of training period (25 March 2018). In the Chittagong region, trees were sampled from Chunati Wildlife Sanctuary, Fasiakhali Wildlife Sanctuary, Bomo Reserve Forest, Kaptai National Park and

Dudhpukuria-Dhopachari Wildlife Sanctuary. Local offices of Bangladesh Forest Department supported the data collection process.

The sample trees were selected considering the pre-pared list (Table 1) and diameter ranges of the selected species. Representative number of trees were sampled from each diameter class. The considered diameter classes were 10-20 cm, 20-30 cm, 30-40 cm and >40 cm.

The selected trees were then sampled following semi-destructive method of data collection for allometric equation development. In this method, three small branches were cut from each sample tree. Then the leaves, leaf containing small branches and small branches were separated and measured for recording the fresh weight. Sub-samples from the tree parts were collected for laboratory analysis as per the methods prescribed by Mahmood *et al*. (2016).

4. Summary of outcomes of the training programme

4.1 Tree species sampled

Besides the listed species mentioned in Table 1, more tree species were sampled for AE data collection. In together 179 individuals belonging to 15 species were sampled from the whole hill zone (Table 3). The data were recorded in the field in data collection forms prescribed in Mahmood et al. (2016). Each sample trees are designated a diameter classes (i.e. 0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm and >40 cm) and this is checked regularly during selecting a tree individual to ensure data collection from each diameter class. Several new tree species were also included in the list and sampled i.e. *Terminalia arjuna, Artocarpus chaplasha, Aquilaria malaccensis* and *Swietenia mahogany* considering their frequent presence. However, individuals of some listed tree species i.e. *Senna siamea* and *Bombax ceiba* were not abundant in the forest hence their sample number was not adequate. No tree could be sampled for *Pterospermum acerifolium* because of rare presence of the tree in the forest.

4.2 Tree measurement

Basic tree parameters i.e. DBH, total height, crown form, crown diameter and diameter at stump height were measured during the start of sampling a tree. Crown form and shape data was collected following Frank (2010). Then a labour skilled in tree climbing climb on the sample trees with diameter tape, measuring tape and chopper. The tree climber measured the length of each tree section and diameter at both end of the section with support from the resource person and participants (Figure 1). Tree stems were sectioned in points of every bends, irregular forms and branching. For each section the length and diameter at both end was measured and recorded. Every sample tree was measured up to 10 cm diameter height point.

a. Climbing large trees   b. Branch cutting

c. Seperating leaves   d. Measuring leaves

e. Measuring branch sections   f. Measurement of tree sections

Figure 1: Tree data collection for allometric equation development following semi-destructive method

4.3   Trimming branches and Sub-sampling tree parts

As per semi-destructive method, at least three small branches were trimmed from each sample tree and 10 sub-samples for each plant parts (i.e. leaf, bark, leaf containing small branches and small branches) were prepared for laboratory analysis. Samples were also collected for wood density, bark fresh weight to wood volume without bark ratio and leaf fresh biomass to leaf containing smaller branch ratio. The number of collected sub-samples for AE development are mentioned in **Table 3**. After appropriately coding, the collected samples are sent to the Khulna University laboratory for further analysis to oven dry weight, carbon content and wood density.

Table 3: Details of the tree species sampled for AE data collection [here, L = Leaves, LCSB = Leaf containing small branch, SB = Small branch, WD = Wood density]

SN	Tree species	Number of individuals sampled	Number of subsamples collected				
			L	LCSB	SB	WD	Bark
1	*Tectona grandis*	15	7	7	7	7	7
2	*Dipterocarpus spp.*	16	8	8	8	8	8
3	*Syzygium spp.*	15	10	10	10	10	10
4	*Hevea brasiliensis*	15	5	5	5	5	5
5	*Lagerstroemia speciosa*	15	10	10	10	10	10
6	*Albizia spp.*	9	5	5	5	5	5
7	*Terminalia bellirica*	15		6	6	6	6
8	*Bombax ceiba*	2		3	3	3	3
9	*Eucalyptus* spp.	6	6	6	6	6	6
10	*Senna siamea*	7	3	3	3	3	3
11	*Terminalia arjuna*	16	5	5	5	5	5
12	*Artocarpus chaplasha*	15	8	8	8	8	8
13	*Aquilaria malaccensis*	15	4	4	4	4	4
14	*Hopea odorata*	3	5	5	5	5	5
15	*Swietenia mahogany*	15	5	5	5	5	5

5. Recommendation and next steps

- Tree climber is a key person for measurement of the length and diameter at different sections of a sample tree. But, skilled tree climber is not available in all regions. Hence, sometimes the training program faced difficulty due to unavailability of skilled tree climber. Moreover, it is a risky and tough job for the tree climber. It is recommended for find better options for measurement of tree sections by replacing the tree climber.
- Input of the field data, laboratory processing and analysis of the sub-sample data in Khulna University and data analysis for development of allometric equation are the next steps that demand concentration for immediate actions.

6. References

Frank, E.F. 2010. Crown Volume Estimates, Eastern Native Tree Society. Website http://www.nativetreesociety.org/measure/volume/Crown+Volume+Estimates.pdf 29 pages. Accessed February 12, 2016

Mahmood, H., Siddique, M.R.H., Abdullah, S.M.R., Akhter, M., Islam, S.M.Z. 2016. Field measurement protocol on tree allometric equations for estimating above-ground biomass and volume in Bangladesh. Food & Agriculture Organization of the United Nations, Rome, Italy and Forest Department, Government of the People's Republic of Bangladesh, 101 pp.

Appendix 1: List of participants and resource persons

Name	Email	Organization	Joining time
Training participants			
Md. Muslim Uddin, student	md.muslimuddin315@gmail.com 01815567995, 01673875669	IFESCU	4 to 25th March 2018
Safayetur Rahman, student	sr.sayem@gmail.com 01735226062	IFESCU	4 to 25th March 2018
Md. Mahmudul Hasan, student	pabonworld@gmail.com +8801748136738	DFES, SUST	4 to 25th March 2018
Sajal Saha, student	sajal.fes@gmail.com 01927656168	DFES, SUST.	4 to 25th March 2018
Resource persons			
S.M. Zahirul Islam, Research Officer, Forest Inventory Division	zahir.fid.bfri@yahoo.com 01837000010	BFRI	4 to 13th March 2018
Mohammad Raqibul Hasan Siddique, Associate professor	Raqibulhasan_fwt@yahoo.com 01716422182	KU	14 to 25th March 2018

Appendix 2: Agenda and detail schedule of data collection

Data	Place of training	Resource person
04 March 2018	BFI headquarter, Bana Bhaban, Agargao, Dhaka	S.M. Zahirul Islam and Mohammad Raqibul Hasan Siddique
05-07 March 2018	Khadimnagar National Park, Sylhet	S.M. Zahirul Islam
08-10 March 2018	Lawachara National Park	S.M. Zahirul Islam
11-12 March 2018	Satachari National Park	S.M. Zahirul Islam
13 March 2018	Move to Chittagong region	Mohammad Raqibul Hasan Siddique
14-16 March 2018	Chunati Wildlife Sanctuary	Mohammad Raqibul Hasan Siddique
17-19 March 2018	Fasiakhali Wildlife Sanctuary	Mohammad Raqibul Hasan Siddique
20-21 March 2018	Bomo Reserve Forest	Mohammad Raqibul Hasan Siddique
22-23 March 2018	Kaptai National Park	Mohammad Raqibul Hasan Siddique
24 March 2018	Dudhpukuria-Dhopachari Wildlife Sanctuary	Mohammad Raqibul Hasan Siddique