Training on laboratory analysis of the samples used for hill zone Allometric Equation (AE)

Bangladesh Forest Department

27 March – 10 April 2018

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Food and Agriculture Organization of the United Nations

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) and the Food and Agriculture Organization of the United Nations (FAO) are supporting the development of technical and financial resources that will assist in institutionalizing 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, and climate change mitigation.

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Disclaimer

This report is designed to reflect the activities and progress related to the project GCP/GD/058/USAID "Strengthening National Forest Inventory and Satellite Forest Monitoring System in support of REDD+ in Bangladesh". This report is not authoritative information sources – it does not reflect the official position of the supporting international agencies including USAID or FAO and should not be used for official purposes. Should readers find any errors in the document or would like to provide comments for improving its quality they are encouraged to contact one of above contacts.

Executive Summary

Sub-samples that collected during the training programme on allometric equation development using semi-destructive method in the Hill Zone need to process to get conversion ratios of fresh to oven-dry weight, wood and bark density. For this purpose, a fifteen days from 27th March to 10th April 2018 training was organized for proceeding the sub-sample and determination of carbon for the Hill Zone allometric equation development. However, this training programme was supported by FAO under a project titled "Strengthening National Forest Inventory and Satellite. Land Monitoring System in support of REDD+ in Bangladesh". The objective was 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 this training were to develop stakeholder's capacity on sample processing and carbon determination of different parts of sampled species to convert the volume data into biomass data. This laboratory training program involved 2 participants (students with forestry background) and 1 resource persons from Khulna University. Conversion ratio for fresh to oven-dry weight and carbon concentration of different parts found to vary with species and plant parts.

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Introduction

Field data collection of Bangladesh Forest Inventory (BFI) has been started science November 2016 under a project titled "Strengthening National Forest Inventory and Satellite Land Monitoring System in support of REDD+ in Bangladesh" of Forest Department. One of the objective of this inventory is to assess the present carbon stock in five different zones (Hill, Village, Sal, Sundarbans and Coastal) of Bangladesh (Akhter et al., 2016). However, this assessment requires validated allometric equation of tree species. In Bangladesh, 222 verified allometric equations which covers only 39 species of trees, shrubs and bamboos (Mahmood et al. 2006). But, Bangladesh National Forest Inventory already recorded more than 280 tree species. Considering this situation, Bangladesh Forest Department and FAO have initiated to derive some common allometric equations for zones. Meanwhile, they developed a common allometric equation for the Sal zone. The common allometric equation for the Sundarbans, village and coastal afforested areas are under processing. However, a training programme has just completed with semi-destructive method of data collection from the Hill Zone. The semi-structure method of AE development requires collection of volume data from the field and collection of sub-samples to convert the volume data into biomass. As next step of field data and sub-sample collection, this training programme is designed to strength capacity of national stakeholders as well as generate data for developing a common allometric equation for hill zone of Bangladesh.

Objectives

The general objective of this training was 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 were as follow:

- Leaf and leaf containing smaller branches (LSB) fresh weight conversion ratio
- Fresh to oven-dry conversion ratio
- Wood and bark density

Description of the training program

This training involved 2 students with forestry background from Forestry and Wood Technology Discipline, Khulna University and one resource persons from Khulna University. necessary funds were

ensured by the project for smooth operation of training and data collection from different locations of the hill zone.

Sample processing

Leaf and leaf containing smaller branches (LSB) fresh weight conversion ratio

The parts (leaf, branches, stem and bark) of a sample tree need to spate for accurate measurement of biomass of the hole tree. However, this separation need extensive labour specially for the leaves. To overcome this difficulty, we measured the biomass of leaves along with leaf containing smaller branches (LSB). Now we need a conversion ratio to estimate the biomass of leaf and LSB. The following Table 1 presenting the conversion ratio of leaf and LSB.

Table 1: *Conversion ratio of fresh weight of leaf and leaf containing smaller branches (LSB)*

Species	Average	Standard Error
Albizia spp	0.607	0.043
Aquilaria malaccensis	0.568	0.0252
Artocarpus chaplasha	0.701	0.0268
Bombax ceiba	NA	NA
Dipterocarpus spp	0.642	0.0345
Eucalyptus spp	0.675	0.0182
Hevea brasiliensis	0.586	0.0339
Hopea odorata	0.523	0.033
Lagerstroemia speciose	0.662	0.0226
Swietenia mahagoni	0.497	0.0303
Syzygium spp	0.655	0.0362
Tectona grandis	0.718	0.0313
Terminalia arjuna	0.561	0.0275
Terminalia bellirica	NA	NA
Senna siamea	0.571	0.0214

Fresh to oven-dry conversion ratio

Sub samples of leaf, leaf containing smaller branch, smaller branch (dia <7 cm), bigger branch (dia> 7 cm) and stem of 15 species (*Dipterocarpus* spp*. Artocarpus chaplasha, Terminalia arjuna, Lagerstroemia speciosa, Syzygium* spp*., Aquilaria malaccensis, Tectona grandis, Eucalyptus* spp*., Hopea odorata, Albizia* spp*., Hevea brasiliensis, Terminalia bellirica, Bombax ceiba,* and *Swietenia mahagoni*) were oven-dried at 80 ^{o}C until constant weight. The following Table 2 presenting the fresh to oven-dry weight conversion ratio.

Table 2: *Fresh to oven-dry weight conversion ratio of different part of tree species*

Species	Leaf		Leaf containing smaller branch		Smaller branch 9Dia < 7 cm)	
	Average	Standard Error	Average	Standard Error	Average	Standard Error
Albizia spp.	0.308	0.0008	0.367	0.0222	0.495	0.003
Aquilaria malaccensis	0.374	0.0029	0.372	0.002	0.388	0.0011
Artocarpus chaplasha	0.335	0.0021	0.331	0.0135	0.464	0.0141
Bombax ceiba			0.302	0.0068	0.342	0.0079
Dipterocarpus spp	0.246	0.0134	0.336	0.0191	0.506	0.0054
Eucalyptus spp	0.286	0.0102	0.407	0.0136	0.448	0.0081
Hevea brasiliensis	0.293	0.0043	0.347	0.0094	0.493	0.0066
Hopea odorata	0.284	0.004	0.347	0.0105	0.398	0.0038
Lagerstroemia speciosa	0.135	0.0018	0.397	0.0314	0.433	0.0091
Swietenia mahagoni	0.207	0.0007	0.301	0.0137	0.457	0.0065
Syzygium spp	0.428	0.0109	0.418	0.0105	0.491	0.0024
Tectona grandis	0.457	0.0321	0.371	0.0041	0.428	0.0042
Terminalia arjuna	0.397	0.0154	0.432	0.0075	0.465	0.0071
Terminalia bellirica			0.486	0.0107	0.508	0.0108
Senna siamea	0.282	0.0015	0.363	0.0161	0.539	0.0014

Wood and bark density

Wood and bark density of the samples tree species are required to estimate the oven-dry biomass of stem and bark from their volume data that collected from the field. The density data found to vary with species. The following Table 3 presenting the wood and bark density of the sampled species from the hill zone.

Table 3:Wood and bark density of the sampled species

Species	Bark density (kg/m^3)		Wood density (kg/m^3)	
	Average	Standard Error	Average	Standard Error
Albizia spp.	495	10	572	25
Aquilaria malaccensis	340	13	32	12
Artocarpus chaplasha	415	15	459	9
Bombax ceiba	420	10	314	41
Dipterocarpus spp	560	14	619	21
Eucalyptus spp	612	12	721	33
Hevea brasiliensis	485	15	492	17
Hopea odorata	543	15	635	45
Lagerstroemia speciosa	513	11	595	45
Swietenia mahagoni	510	41	630	22
Syzygium spp	532	17	673	46
Tectona grandis	423	11	720	23
Terminalia arjuna	621	15	822	118
Terminalia bellirica	560	13	760	123
Senna siamea	510	11	660	87

Carbon concentration in plant parts

The supplied sub-samples (leaf, LSB, smaller branch (dia <7 cm), bigger branch (dia> 7 cm), bark of bigger branch, stem and bark of stem) of 15 species were crushed and sieved. This processed sample were ignited at 450 ^{o}C for 5 hours to determine the loss of ignition. The carbon concentration in the plant samples were estimated from the 50% of ash free dry weight of the ignited sample. The carbon concentration found to vary with species and plant parts. The following table presenting the carbon concentration in plant parts of 15 species.

	Carbon concentration (%) in plant parts						
Scientific name	**Leaf**	**LSB**	**Smaller branch (dia <7 cm)**	**Bigger branch (dia>7 cm)**	**Bark of bigger branch**	**Stem**	**Bark of stem**
Albizia spp	47.90	47.16	48.66	48.22	47.29	48.92	47.55
Aquilaria malaccensis	45.70	47.79	48.40	48.15	45.75	48.75	45.81
Artocarpus chaplasha	N/A	43.20	44.94	47.10	44.08	47.30	44.91
Bombax ceiba	N/A	46.56	48.25	48.01	47.62	48.21	47.91
Dipterocarpus spp	47.00	48.32	48.94	48.52	45.74	48.62	46.02
Eucalyptus spp	46.31	47.82	48.71	49.80	45.09	49.88	45.66
Hevea brasiliensis	46.64	46.74	46.60	49.46	48.29	49.43	48.88
Hopea odorata	46.91	44.65	45.91	48.22	45.35	48.24	45.77
Lagerstroemia speciosa	42.96	45.77	47.95	49.26	44.29	49.21	45.11
Swietenia mahagoni	46.42	45.58	45.97	49.14	45.04	49.10	45.55
Senna siamea	47.93	47.87	49.48	49.41	46.41	49.51	46.88
Syzygium spp	47.10	46.64	47.36	48.73	47.18	48.98	47.33
Tectona grandis	44.80	45.05	47.79	49.14	44.74	49.24	44.86
Terminalia arjuna	45.49	46.22	47.73	48.49	40.31	48.84	40.44
Terminalia bellirica	N/A	N/A	41.14	49.43	45.63	49.54	45.99

Recommendation and next steps

- It is recommended to teak 10 sub-samples for estimating fresh to oven-dry conversion ratio.
- Input of the field data and their processing to get dry weight and carbon in above-ground biomass. Finally, data analysis for the development of a common allometric equation and species specific allometric equation for the Hill Zone of Bangladesh.

References

Akhter, M., et al. (2016). "Zoning for tree and forest assessment in Bangladesh. Bangladesh Forest Department and Food and Agricultural Organization of the United Nations, Dhaka, Bangladesh."

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 participant*

Name	Email	Organization	Joining time
Training participants			
Shraboni Deb	Shrabonided60@gmail.com	MS Student Khulna University	27 March to 10 April 2018
Naif Chowdhury	naiffwt@gmail.com	MS Student Khulna University	27 March to 10 April 2018
Resource persons			
Dr. Mahmood Hossain	mahmoodhossain@hotmail.com	Khulna University	27 March to 10 April 2018

***Appendix 2**: Agenda and detail schedule of sample processing*

Data	Place of training	Activities	Resource person
27/03/2018 to 31/03/2018	Nutrient Dynamics laboratory Forestry and Wood Technology Discipline Khulna University	Sample coding for drying	Dr. Mahmood Hossain Forestry and Wood Technology Discipline Khulna University
01/04/2018 to 03/04/2018	Nutrient Dynamics laboratory Forestry and Wood Technology Discipline Khulna University	Recording of sample dry weight	Dr. Mahmood Hossain Forestry and Wood Technology Discipline Khulna University
04/04/2018 to 05/04/2018	Nutrient Dynamics laboratory Forestry and Wood Technology Discipline Khulna University	Calculation of fresh to oven-dry weight conversion ratio	Dr. Mahmood Hossain Forestry and Wood Technology Discipline Khulna University
08/04/2018 to 10/04/2018	Nutrient Dynamics laboratory Forestry and Wood Technology Discipline Khulna University	Estimation of wood and bark density	Dr. Mahmood Hossain Forestry and Wood Technology Discipline Khulna University