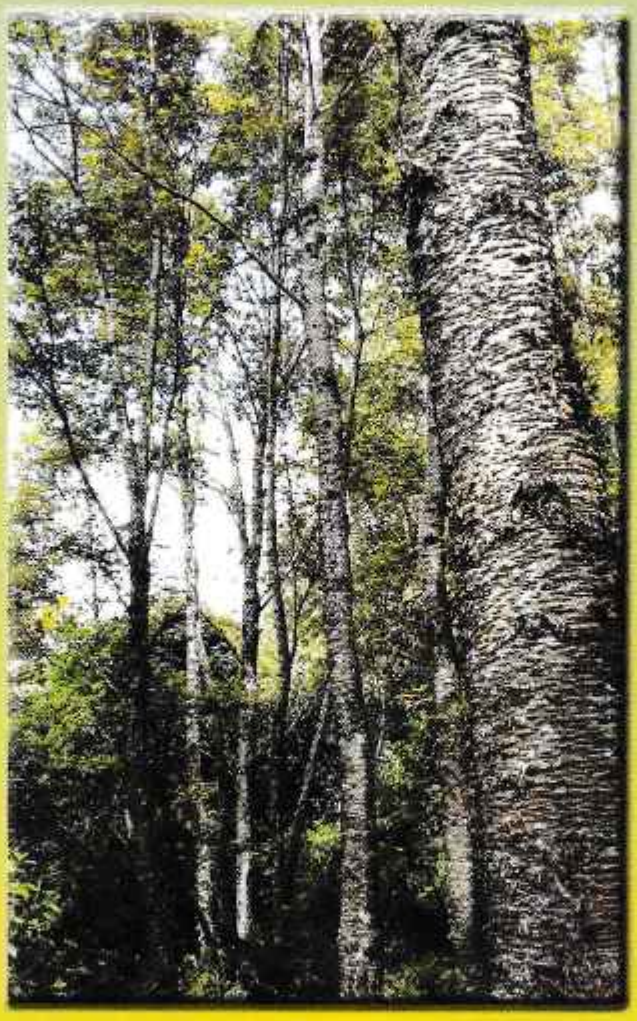
RFRI Report 2

Betula alnoides (Himalayan Birch) Volume, Biomass and Carbon Tables for Meghalaya



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Photographs: Betula alnoides

Betula alnoides (Himalayan Birch)

Volume, Biomass and Carbon Tables for Meghalaya

Introduction

Betula alnoides Buch.-Ham. Ex D. Don. commonly known as Himalayan birch or Indian Birch belongs to the Betulaceae family. The tree is deciduous in nature with open crown and slightly drooping branches, growing up to 30 metres tall. The straight, cylindrical bole of the tree is up to 60 cm in diameter. It is easily identified by the grey bark peeling off horizontally in narrow rolls.

Distribution

This species is naturally distributed in Bhutan, China, India, Laos, Myanmar, Nepal, Thailand and Vietnam. In India it is naturally found in the States of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Himachal Pradesh, Uttarakhand and Darjeeling region of West Bengal from 500 to 3000 m elevation.

Habitat

This species grows in tropical to subtropical forests in association with oaks, alder and herbaceous subtropical ground flora. In the Himalayas, this species is one of the main elements in temperate deciduous forests associated with Green Oak, Deodar and Silver fir trees. This species is also reported as a primary colonizer following disturbance such as landslides or road construction. It is used as a pioneer species for restoration projects in Thailand, due to its fast growth, dense weed suppressing crown and seed dispersal by birds and bats. It is also found along the rivers where gravels have been exposed due to floods, and is tolerant to varying ranges of soil texture and moisture. The species is widespread and common across most of its distribution. However, it is listed as locally rare in Garhwal North West Himalayas.

Uses of the tree

The wood of *B. alnoides* is hard, coarse and used for timber as well as furniture, cabinet work and household utensil making. It is also used as firewood. The

bark is used as a medicine for dislocated bones and snake-bite antidote when mixed with hot butter; it is antiseptic and also cures hysteria. The aromatic oil from bark can be used in the leather industry and the leaves are lopped for fodder. It is considered a holy plant by Chadar (Tagin) tribe in Arunachal Pradesh (Shaw et al. 2014).

Need for volume, biomass and carbon tables

The objective of forest mensuration is to estimate quantity of wood/timber contained in the forest or plantation, in terms of volume or biomass. The volume of trees is calculated either after felling the tree or in the standing form. For volume estimation of standing trees, mathematical models developed through multiple regression analyses are the most suitable methods which avoid felling of trees or destructive approach for volume, biomass and carbon stock estimation in the forest ecosystems. Once developed the volume and biomass tables can be used either by the owners of the tree or the buyer to decide on the value. The carbon tables are useful, if the trees are raised as a part of any project involving carbon trading. In Meghalaya, *Betula alnoides* is available in the forests owned by the Government as well as the communities, and is in trade as timber. Therefore, a need was felt for volume, biomass and carbon tables of birch in Meghalaya.

Methodology (non destructive method)

The following parameters were recorded for development of volume/biomass equations

1. Girth at breast height (GBH) at 1.37 m above ground level for each individual tree was measured using measuring tape and converted into diameter at breast height (DBH) using the following formula:

$$(\text{DBH}) = \frac{\text{Girth at 1.37 m above ground}}{3.14}$$

2. Girth at the base of trees were measured and converted into basal diameter.

$$\text{Basal diameter} = \frac{\text{Girth at the base of tree}}{3.14}$$

Height of each individual tree was measured using **Nikon 550A Laser Range Finder**.

Diameter at each end point and at the centre portion of frustum (smaller logs) was measured in standing trees using **Haglof Mantax Black Caliper with Gator Eyes** and the height of the lower and upper ends of the frustum were measured using Nikon 550A Laser range finder, to arrive at the centre of frustum. Stem volume (m^3) of *B. alnoides* was estimated using diameter class wise regression models developed in this study. The stem volume was converted into biomass (kg/tree) using wood specific gravity (0.573 gm/cm^3) for preparation of regional biomass tables. The stem biomass was further converted into carbon content multiplying with 0.5 to prepare carbon tables (kg/tree).

(a) Utilization of volume, biomass and carbon tables

Stem volume tables were prepared considering height and DBH as an independent variables and volume as a dependent variable in the form of ($V=d^2h$). Volume tables were also prepared using tree DBH as a single independent variable in the form of ($V=d^2$). The regional volume tables prepared for three diameter classes *viz.*, 10-30, 31-50 and >50 cm can be used by the Researchers, Academicians, Forest Officials and Farmers to estimate volume of standing trees for timber extraction from forest areas and community owned plantations (Table 1-3). Table 4-9 shows biomass and carbon values (kg/tree) of particular diameter and height classes (having diameter class interval of 1 cm and height class interval of 1 m). Table 10-11 shows the volume, biomass and carbon content estimated using regression models in the form of ($V=d^2$). The regional yield, carbon tables and best fit regression models can be used for forest biomass and carbon sequestration studies as well as developing projects under REDD+ activities, Clean Development Mechanism (CDM) and National Green House Gas inventories.

References:

Shaw, K., Roy, S. and Wilson, B. 2014. *Betula alnoides*. The IUCN Red List of Threatened Species. 2014. e.T194256A2306879.

Table 1 Volume table (m^3) for *Betula alnoides* (10-30 cm diameter class)

Diameter at breast height (cm)	Height (m)														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	0.040	0.044	0.047	0.051	0.055	0.058	0.062	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.091
11	0.049	0.053	0.057	0.062	0.066	0.071	0.075	0.079	0.084	0.088	0.093	0.097	0.102	0.106	0.110
12	0.058	0.063	0.068	0.074	0.079	0.084	0.089	0.095	0.100	0.105	0.110	0.116	0.121	0.126	0.131
13	0.068	0.074	0.080	0.086	0.093	0.099	0.105	0.111	0.117	0.123	0.130	0.136	0.142	0.148	0.154
14	0.079	0.086	0.093	0.100	0.107	0.114	0.122	0.129	0.136	0.143	0.150	0.157	0.165	0.172	0.179
15	0.090	0.099	0.107	0.115	0.123	0.131	0.140	0.148	0.156	0.164	0.172	0.181	0.189	0.197	0.205
16	0.103	0.112	0.121	0.131	0.140	0.150	0.159	0.168	0.178	0.187	0.196	0.206	0.215	0.224	0.234
17	0.116	0.127	0.137	0.148	0.158	0.169	0.179	0.190	0.200	0.211	0.222	0.232	0.243	0.253	0.264
18	0.130	0.142	0.154	0.166	0.177	0.189	0.201	0.213	0.225	0.237	0.248	0.260	0.272	0.284	0.296
19	0.145	0.158	0.171	0.184	0.198	0.211	0.224	0.237	0.250	0.264	0.277	0.290	0.303	0.316	0.329
20	0.161	0.175	0.190	0.204	0.219	0.234	0.248	0.263	0.277	0.292	0.307	0.321	0.336	0.350	0.365
21	0.177	0.193	0.209	0.225	0.241	0.258	0.274	0.290	0.306	0.322	0.338	0.354	0.370	0.386	0.402
22	0.194	0.212	0.230	0.247	0.265	0.283	0.300	0.318	0.336	0.353	0.371	0.389	0.406	0.424	0.442
23	0.212	0.232	0.251	0.270	0.290	0.309	0.328	0.348	0.367	0.386	0.405	0.425	0.444	0.463	0.483
24	0.231	0.252	0.273	0.294	0.315	0.336	0.357	0.378	0.399	0.420	0.442	0.463	0.484	0.505	0.526
25	0.251	0.274	0.297	0.319	0.342	0.365	0.388	0.411	0.433	0.456	0.479	0.502	0.525	0.548	0.570
26	0.271	0.296	0.321	0.345	0.370	0.395	0.419	0.444	0.469	0.493	0.518	0.543	0.568	0.592	0.617
27	0.293	0.319	0.346	0.373	0.399	0.426	0.452	0.479	0.506	0.532	0.559	0.585	0.612	0.639	0.665
28	0.315	0.343	0.372	0.401	0.429	0.458	0.486	0.515	0.544	0.572	0.601	0.630	0.658	0.687	0.715
29	0.338	0.368	0.399	0.430	0.460	0.491	0.522	0.553	0.583	0.614	0.645	0.675	0.706	0.737	0.767
30	0.361	0.394	0.427	0.460	0.493	0.526	0.558	0.591	0.624	0.657	0.690	0.723	0.756	0.788	0.821

(The values which are in darker region are within the range of observed data)

Table 2: Volume table for *Betula alnoides* (31-50 cm diameter class) in m^3

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	0.417	0.444	0.472	0.500	0.528	0.555	0.583	0.611	0.639	0.667	0.694	0.722	0.750	0.778	0.805	0.833
32	0.444	0.473	0.503	0.533	0.562	0.592	0.621	0.651	0.681	0.710	0.740	0.769	0.799	0.829	0.858	0.888
33	0.472	0.504	0.535	0.566	0.598	0.629	0.661	0.692	0.724	0.755	0.787	0.818	0.850	0.881	0.913	0.944
34	0.501	0.535	0.568	0.601	0.635	0.668	0.702	0.735	0.768	0.802	0.835	0.869	0.902	0.935	0.969	1.002
35	0.531	0.566	0.602	0.637	0.673	0.708	0.743	0.779	0.814	0.850	0.885	0.920	0.956	0.991	1.027	1.062
36	0.562	0.599	0.637	0.674	0.712	0.749	0.787	0.824	0.861	0.899	0.936	0.974	1.011	1.049	1.086	1.124
37	0.593	0.633	0.673	0.712	0.752	0.791	0.831	0.870	0.910	0.950	0.989	1.029	1.068	1.108	1.147	1.187
38	0.626	0.668	0.709	0.751	0.793	0.835	0.876	0.918	0.960	1.002	1.043	1.085	1.127	1.168	1.210	1.252
39	0.659	0.703	0.747	0.791	0.835	0.879	0.923	0.967	1.011	1.055	1.099	1.143	1.187	1.231	1.275	1.319
40	0.694	0.740	0.786	0.832	0.879	0.925	0.971	1.017	1.064	1.110	1.156	1.202	1.248	1.295	1.341	1.387
41	0.729	0.777	0.826	0.874	0.923	0.972	1.020	1.069	1.117	1.166	1.215	1.263	1.312	1.360	1.409	1.457
42	0.765	0.816	0.867	0.918	0.969	1.020	1.071	1.122	1.173	1.224	1.274	1.325	1.376	1.427	1.478	1.529
43	0.802	0.855	0.908	0.962	1.015	1.069	1.122	1.176	1.229	1.282	1.336	1.389	1.443	1.496	1.550	1.603
44	0.839	0.895	0.951	1.007	1.063	1.119	1.175	1.231	1.287	1.343	1.399	1.455	1.511	1.567	1.623	1.679
45	0.878	0.936	0.995	1.053	1.112	1.170	1.229	1.287	1.346	1.405	1.463	1.522	1.580	1.639	1.697	1.756
46	0.917	0.978	1.040	1.101	1.162	1.223	1.284	1.345	1.407	1.468	1.529	1.590	1.651	1.712	1.773	1.835
47	0.958	1.021	1.085	1.149	1.213	1.277	1.341	1.404	1.468	1.532	1.596	1.660	1.724	1.788	1.851	1.915
48	0.999	1.065	1.132	1.199	1.265	1.332	1.398	1.465	1.531	1.598	1.665	1.731	1.798	1.864	1.931	1.998
49	1.041	1.110	1.180	1.249	1.318	1.388	1.457	1.527	1.596	1.665	1.735	1.804	1.874	1.943	2.012	2.082
50	1.084	1.156	1.228	1.301	1.373	1.445	1.517	1.590	1.662	1.734	1.806	1.879	1.951	2.023	2.095	2.168

(The values which are in darker region are within the range of observed data)

Table 3: Volume table for *Betula alnoides* (>50 cm diameter class) in m^3

Diameter at breast height (cm)	Height (m)																				
	1	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	0.995	1.061	1.128	1.194	1.260	1.327	1.393	1.459	1.525	1.592	1.658	1.724	1.791	1.857	1.923	1.990	2.056	2.122	2.189	2.255	2.321
52	1.034	1.103	1.172	1.241	1.310	1.379	1.448	1.517	1.586	1.655	1.724	1.793	1.862	1.931	2.000	2.069	2.138	2.206	2.275	2.344	2.413
53	1.074	1.146	1.218	1.289	1.361	1.433	1.504	1.576	1.647	1.719	1.791	1.862	1.934	2.006	2.077	2.149	2.221	2.292	2.364	2.435	2.507
54	1.115	1.190	1.264	1.338	1.413	1.487	1.562	1.636	1.710	1.785	1.859	1.933	2.008	2.082	2.156	2.231	2.305	2.379	2.454	2.528	2.603
55	1.157	1.234	1.311	1.388	1.466	1.543	1.620	1.697	1.774	1.851	1.928	2.006	2.083	2.160	2.237	2.314	2.391	2.468	2.546	2.623	2.700
56	1.200	1.279	1.359	1.439	1.519	1.599	1.679	1.759	1.839	1.919	1.999	2.079	2.159	2.239	2.319	2.399	2.479	2.559	2.639	2.719	2.799
57	1.243	1.326	1.408	1.491	1.574	1.657	1.740	1.823	1.906	1.988	2.071	2.154	2.237	2.320	2.403	2.485	2.568	2.651	2.734	2.817	2.900
58	1.287	1.373	1.458	1.544	1.630	1.716	1.801	1.887	1.973	2.059	2.145	2.230	2.316	2.402	2.488	2.573	2.659	2.745	2.831	2.917	3.002
59	1.331	1.420	1.509	1.598	1.687	1.775	1.864	1.953	2.042	2.130	2.219	2.308	2.397	2.485	2.574	2.663	2.752	2.840	2.929	3.018	3.107
60	1.377	1.469	1.561	1.652	1.744	1.836	1.928	2.020	2.111	2.203	2.295	2.387	2.479	2.570	2.662	2.754	2.846	2.938	3.029	3.121	3.213
61	1.423	1.518	1.613	1.708	1.803	1.898	1.993	2.087	2.182	2.277	2.372	2.467	2.562	2.657	2.752	2.847	2.941	3.036	3.131	3.226	3.321
62	1.470	1.568	1.666	1.764	1.862	1.960	2.058	2.156	2.255	2.353	2.451	2.549	2.647	2.745	2.843	2.941	3.039	3.137	3.235	3.333	3.431
63	1.518	1.619	1.721	1.822	1.923	2.024	2.125	2.227	2.328	2.429	2.530	2.631	2.733	2.834	2.935	3.036	3.137	3.239	3.340	3.441	3.542
64	1.567	1.671	1.776	1.880	1.985	2.089	2.193	2.298	2.402	2.507	2.611	2.716	2.820	2.925	3.029	3.133	3.238	3.342	3.447	3.551	3.656
65	1.616	1.724	1.832	1.939	2.047	2.155	2.262	2.370	2.478	2.586	2.693	2.801	2.909	3.017	3.124	3.232	3.340	3.448	3.555	3.663	3.771
66	1.666	1.777	1.888	1.999	2.110	2.222	2.333	2.444	2.555	2.666	2.777	2.888	2.999	3.110	3.221	3.332	3.443	3.554	3.666	3.777	3.888
67	1.717	1.832	1.946	2.060	2.175	2.289	2.404	2.518	2.633	2.747	2.862	2.976	3.091	3.205	3.320	3.434	3.549	3.663	3.777	3.892	4.006
68	1.769	1.887	2.005	2.122	2.240	2.358	2.476	2.594	2.712	2.830	2.948	3.066	3.184	3.302	3.419	3.537	3.655	3.773	3.891	4.009	4.127
69	1.821	1.942	2.064	2.185	2.307	2.428	2.550	2.671	2.792	2.914	3.035	3.157	3.278	3.399	3.521	3.642	3.764	3.885	4.006	4.128	4.249
70	1.874	1.999	2.124	2.249	2.374	2.499	2.624	2.749	2.874	2.999	3.124	3.249	3.374	3.499	3.624	3.749	3.873	3.998	4.123	4.248	4.373

(The values which are in darker region are within the range of observed data)

Table 4 Biomass table (kg/tree) for *Betula alnoides* (10-30 cm diameter class)

Diameter at breast height (cm)	Height (m)														
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
10	23.01	25.10	27.19	29.28	31.37	33.46	35.55	37.65	39.74	41.83	43.92	46.01	48.10	50.19	52.29
11	27.84	30.37	32.90	35.43	37.96	40.49	43.02	45.55	48.08	50.61	53.14	55.67	58.21	60.74	63.27
12	33.13	36.14	39.15	42.16	45.18	48.19	51.20	54.21	57.22	60.23	63.25	66.26	69.27	72.28	75.29
13	38.88	42.41	45.95	49.48	53.02	56.55	60.09	63.62	67.16	70.69	74.23	77.76	81.29	84.83	88.36
14	45.09	49.19	53.29	57.39	61.49	65.59	69.69	73.79	77.89	81.98	86.08	90.18	94.28	98.38	102.48
15	51.76	56.47	61.17	65.88	70.59	75.29	80.00	84.70	89.41	94.12	98.82	103.53	108.23	112.94	117.64
16	58.90	64.25	69.60	74.96	80.31	85.67	91.02	96.37	101.73	107.08	112.44	117.79	123.14	128.50	133.85
17	66.49	72.53	78.58	84.62	90.66	96.71	102.75	108.80	114.84	120.89	126.93	132.97	139.02	145.06	151.11
18	74.54	81.32	88.09	94.87	101.64	108.42	115.20	121.97	128.75	135.53	142.30	149.08	155.85	162.63	169.41
19	83.05	90.60	98.15	105.70	113.25	120.80	128.35	135.90	143.45	151.00	158.55	166.10	173.65	181.20	188.75
20	92.02	100.39	108.76	117.12	125.49	133.85	142.22	150.58	158.95	167.32	175.68	184.05	192.41	200.78	209.15
21	101.46	110.68	119.90	129.13	138.35	147.57	156.80	166.02	175.24	184.47	193.69	202.91	212.14	221.36	230.58
22	111.35	121.47	131.59	141.72	151.84	161.96	172.08	182.21	192.33	202.45	212.57	222.70	232.82	242.94	253.07
23	121.70	132.77	143.83	154.89	165.96	177.02	188.08	199.15	210.21	221.28	232.34	243.40	254.47	265.53	276.59
24	132.51	144.56	156.61	168.65	180.70	192.75	204.79	216.84	228.89	240.94	252.98	265.03	277.08	289.12	301.17
25	143.79	156.86	169.93	183.00	196.07	209.15	222.22	235.29	248.36	261.43	274.50	287.57	300.65	313.72	326.79
26	155.52	169.66	183.80	197.93	212.07	226.21	240.35	254.49	268.63	282.76	296.90	311.04	325.18	339.32	353.46
27	167.71	182.96	198.21	213.45	228.70	243.95	259.19	274.44	289.69	304.93	320.18	335.43	350.67	365.92	381.17
28	180.37	196.76	213.16	229.56	245.95	262.35	278.75	295.15	311.54	327.94	344.34	360.73	377.13	393.53	409.92
29	193.48	211.07	228.66	246.25	263.84	281.43	299.01	316.60	334.19	351.78	369.37	386.96	404.55	422.14	439.73
30	207.05	225.88	244.70	263.52	282.35	301.17	319.99	338.81	357.64	376.46	395.28	414.11	432.93	451.75	470.58

(The values which are in darker region are within the range of observed data)

Table 5 Biomass (kg/tree) for *Betula alnoides* (31-50 cm diameter class)

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	238.71	254.62	270.54	286.45	318.28	318.28	334.19	350.11	366.02	381.93	397.85	413.76	429.67	445.59	461.50	477.42
32	254.36	271.31	288.27	305.23	339.14	339.14	356.10	373.06	390.01	406.97	423.93	440.89	457.84	474.80	491.76	508.71
33	270.50	288.54	306.57	324.60	360.67	360.67	378.70	396.74	414.77	432.80	450.84	468.87	486.90	504.94	522.97	541.01
34	287.15	306.29	325.43	344.57	382.86	382.86	402.00	421.15	440.29	459.43	478.58	497.72	516.86	536.00	555.15	574.29
35	304.28	324.57	344.86	365.14	405.71	405.71	426.00	446.28	466.57	486.86	507.14	527.43	547.71	568.00	588.28	608.57
36	321.92	343.38	364.84	386.30	429.23	429.23	450.69	472.15	493.61	515.07	536.53	558.00	579.46	600.92	622.38	643.84
37	340.05	362.72	385.39	408.06	453.40	453.40	476.07	498.75	521.42	544.09	566.76	589.43	612.10	634.77	657.44	680.11
38	358.68	382.60	406.51	430.42	478.24	478.24	502.16	526.07	549.98	573.89	597.81	621.72	645.63	669.54	693.45	717.37
39	377.81	403.00	428.18	453.37	503.75	503.75	528.93	554.12	579.31	604.50	629.68	654.87	680.06	705.24	730.43	755.62
40	397.43	423.93	450.42	476.92	529.91	529.91	556.41	582.90	609.40	635.89	662.39	688.88	715.38	741.87	768.37	794.87
41	417.55	445.39	473.23	501.06	556.74	556.74	584.57	612.41	640.25	668.08	695.92	723.76	751.60	779.43	807.27	835.11
42	438.17	467.38	496.59	525.80	584.23	584.23	613.44	642.65	671.86	701.07	730.28	759.49	788.71	817.92	847.13	876.34
43	459.28	489.90	520.52	551.14	612.38	612.38	643.00	673.62	704.23	734.85	765.47	796.09	826.71	857.33	887.95	918.57
44	480.89	512.95	545.01	577.07	641.19	641.19	673.25	705.31	737.37	769.43	801.49	833.55	865.61	897.67	929.73	961.79
45	503.00	536.53	570.07	603.60	670.67	670.67	704.20	737.73	771.27	804.80	838.33	871.87	905.40	938.93	972.47	1006.00
46	525.60	560.65	595.69	630.73	700.81	700.81	735.85	770.89	805.93	840.97	876.01	911.05	946.09	981.13	1016.17	1051.21
47	548.71	585.29	621.87	658.45	731.61	731.61	768.19	804.77	841.35	877.93	914.51	951.09	987.67	1024.25	1060.83	1097.41
48	572.30	610.46	648.61	686.76	763.07	763.07	801.22	839.38	877.53	915.69	953.84	991.99	1030.15	1068.30	1106.45	1144.61
49	596.40	636.16	675.92	715.68	795.20	795.20	834.96	874.72	914.48	954.24	994.00	1033.76	1073.52	1113.28	1153.04	1192.80
50	620.99	662.39	703.79	745.19	827.99	827.99	869.38	910.78	952.18	993.58	1034.98	1076.38	1117.78	1159.18	1200.58	1241.98

(The values which are in darker region are within the range of observed data)

Table 6 Biomass (kg/tree) for *Betula alnoides* (>50 cm diameter class)

Diameter at breast height (cm)	Height (m)																				
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	570.07	608.07	646.08	684.08	722.09	760.09	798.09	836.10	874.10	912.11	950.11	988.12	1026.12	1064.13	1102.13	1140.14	1178.14	1216.14	1254.15	1292.15	1330.16
52	592.64	632.15	671.66	711.17	750.68	790.19	829.70	869.21	908.72	948.23	987.74	1027.25	1066.76	1106.27	1145.78	1185.28	1224.79	1264.30	1303.81	1343.32	1382.83
53	615.66	656.70	697.74	738.79	779.83	820.87	861.92	902.96	944.01	985.05	1026.09	1067.14	1108.18	1149.22	1190.27	1231.31	1272.35	1313.40	1354.44	1395.49	1436.53
54	639.11	681.71	724.32	766.93	809.54	852.14	894.75	937.36	979.96	1022.57	1065.18	1107.79	1150.39	1193.00	1235.61	1278.21	1320.82	1363.43	1406.04	1448.64	1491.25
55	663.00	707.20	751.40	795.60	839.80	884.00	928.20	972.40	1016.60	1060.79	1104.99	1149.19	1193.39	1237.59	1281.79	1325.99	1370.19	1414.39	1458.59	1502.79	1546.99
56	687.32	733.15	778.97	824.79	870.61	916.43	962.25	1008.08	1053.90	1099.72	1145.54	1191.36	1237.18	1283.01	1328.83	1374.65	1420.47	1466.29	1512.11	1557.94	1603.76
57	712.09	759.56	807.04	854.51	901.98	949.46	996.93	1044.40	1091.87	1139.35	1186.82	1234.29	1281.76	1329.24	1376.71	1424.18	1471.66	1519.13	1566.60	1614.07	1661.55
58	737.30	786.45	835.60	884.76	933.91	983.06	1032.21	1081.37	1130.52	1179.67	1228.83	1277.98	1327.13	1376.29	1425.44	1474.59	1523.75	1572.90	1622.05	1671.20	1720.36
59	762.94	813.80	864.66	915.53	966.39	1017.25	1068.12	1118.98	1169.84	1220.70	1271.57	1322.43	1373.29	1424.15	1475.02	1525.88	1576.74	1627.60	1678.47	1729.33	1780.19
60	789.02	841.62	894.22	946.83	999.43	1052.03	1104.63	1157.23	1209.83	1262.43	1315.04	1367.64	1420.24	1472.84	1525.44	1578.04	1630.64	1683.24	1735.85	1788.45	1841.05
61	815.54	869.91	924.28	978.65	1033.02	1087.39	1141.76	1196.13	1250.50	1304.87	1359.23	1413.60	1467.97	1522.34	1576.71	1631.08	1685.45	1739.82	1794.19	1848.56	1902.93
62	842.50	898.67	954.83	1011.00	1067.17	1123.33	1179.50	1235.67	1291.83	1348.00	1404.17	1460.33	1516.50	1572.66	1628.83	1685.00	1741.16	1797.33	1853.50	1909.66	1965.83
63	869.90	927.89	985.88	1043.87	1101.82	1159.86	1217.85	1275.85	1333.84	1391.83	1449.83	1507.82	1565.81	1623.81	1681.80	1739.79	1797.78	1855.78	1913.77	1971.76	2029.76
64	897.73	957.58	1017.43	1077.28	1137.13	1196.97	1256.82	1316.67	1376.52	1436.37	1496.22	1556.07	1615.92	1675.76	1735.61	1795.46	1855.31	1915.16	1975.01	2034.86	2094.70
65	926.00	987.74	1049.47	1111.20	1172.94	1234.67	1296.41	1358.14	1419.87	1481.61	1543.34	1605.07	1666.81	1728.54	1790.27	1852.01	1913.74	1975.47	2037.21	2098.94	2160.68
66	954.72	1018.36	1082.01	1145.66	1209.31	1272.95	1336.60	1400.25	1463.90	1527.54	1591.19	1654.84	1718.49	1782.14	1845.78	1909.43	1973.08	2036.73	2100.37	2164.02	2227.67
67	983.87	1049.46	1115.05	1180.64	1246.23	1311.82	1377.41	1443.00	1508.59	1574.18	1639.78	1705.37	1770.96	1836.55	1902.14	1967.73	2033.32	2098.91	2164.50	2230.09	2295.69
68	1013.45	1081.02	1148.58	1216.14	1283.71	1351.27	1418.84	1486.40	1553.96	1621.53	1689.09	1756.65	1824.22	1891.78	1959.34	2026.91	2094.47	2162.03	2229.60	2297.16	2364.73
69	1043.48	1113.05	1182.61	1252.18	1321.74	1391.31	1460.87	1530.44	1600.00	1669.57	1739.13	1808.70	1878.26	1947.83	2017.40	2086.96	2156.53	2226.09	2295.66	2365.22	2434.79
70	1073.95	1145.54	1217.14	1288.73	1360.33	1431.93	1503.52	1575.12	1646.72	1718.31	1789.91	1861.51	1933.10	2004.70	2076.29	2147.89	2219.49	2291.08	2362.68	2434.28	2505.87

(The values which are in darker region are within the range of observed data)

Table 7 Carbon (kg/tree) for *Betula alnoides* (10-30 cm diameter class)

Diameter at breast height (cm)	Height (m)														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	11.50	12.55	13.59	14.64	15.69	16.73	17.78	18.82	19.87	20.91	21.96	23.01	24.05	25.10	26.14
11	13.92	15.18	16.45	17.71	18.98	20.25	21.51	22.78	24.04	25.31	26.57	27.84	29.10	30.37	31.63
12	16.56	18.07	19.58	21.08	22.59	24.09	25.60	27.11	28.61	30.12	31.62	33.13	34.63	36.14	37.65
13	19.44	21.21	22.97	24.74	26.51	28.28	30.04	31.81	33.58	35.35	37.11	38.88	40.65	42.41	44.18
14	22.55	24.60	26.65	28.69	30.74	32.79	34.84	36.89	38.94	40.99	43.04	45.09	47.14	49.19	51.24
15	25.88	28.23	30.59	32.94	35.29	37.65	40.00	42.35	44.70	47.06	49.41	51.76	54.12	56.47	58.82
16	29.45	32.12	34.80	37.48	40.16	42.83	45.51	48.19	50.86	53.54	56.22	58.90	61.57	64.25	66.93
17	33.24	36.27	39.29	42.31	45.33	48.35	51.38	54.40	57.42	60.44	63.47	66.49	69.51	72.53	75.55
18	37.27	40.66	44.05	47.43	50.82	54.21	57.60	60.99	64.37	67.76	71.15	74.54	77.93	81.32	84.70
19	41.53	45.30	49.08	52.85	56.63	60.40	64.18	67.95	71.73	75.50	79.28	83.05	86.83	90.60	94.38
20	46.01	50.19	54.38	58.56	62.74	66.93	71.11	75.29	79.48	83.66	87.84	92.02	96.21	100.39	104.57
21	50.73	55.34	59.95	64.56	69.17	73.79	78.40	83.01	87.62	92.23	96.84	101.46	106.07	110.68	115.29
22	55.67	60.74	65.80	70.86	75.92	80.98	86.04	91.10	96.16	101.23	106.29	111.35	116.41	121.47	126.53
23	60.85	66.38	71.91	77.45	82.98	88.51	94.04	99.57	105.11	110.64	116.17	121.70	127.23	132.77	138.30
24	66.26	72.28	78.30	84.33	90.35	96.37	102.40	108.42	114.44	120.47	126.49	132.51	138.54	144.56	150.58
25	71.89	78.43	84.97	91.50	98.04	104.57	111.11	117.64	124.18	130.72	137.25	143.79	150.32	156.86	163.39
26	77.76	84.83	91.90	98.97	106.04	113.11	120.17	127.24	134.31	141.38	148.45	155.52	162.59	169.66	176.73
27	83.86	91.48	99.10	106.73	114.35	121.97	129.60	137.22	144.84	152.47	160.09	167.71	175.34	182.96	190.58
28	90.18	98.38	106.58	114.78	122.98	131.18	139.37	147.57	155.77	163.97	172.17	180.37	188.57	196.76	204.96
29	96.74	105.53	114.33	123.12	131.92	140.71	149.51	158.30	167.10	175.89	184.69	193.48	202.27	211.07	219.86
30	103.53	112.94	122.35	131.76	141.17	150.58	160.00	169.41	178.82	188.23	197.64	207.05	216.47	225.88	235.29

(The values which are in darker region are within the range of observed data)

Table 8 Carbon (kg/tree) for *Betula alnoides* (31-50 cm diameter class)

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	119.35	127.31	135.27	143.22	151.18	159.14	167.10	175.05	183.01	190.97	198.92	206.88	214.84	222.79	230.75	238.71
32	127.18	135.66	144.14	152.61	161.09	169.57	178.05	186.53	195.01	203.49	211.96	220.44	228.92	237.40	245.88	254.36
33	135.25	144.27	153.28	162.30	171.32	180.34	189.35	198.37	207.39	216.40	225.42	234.44	243.45	252.47	261.49	270.50
34	143.57	153.14	162.72	172.29	181.86	191.43	201.00	210.57	220.14	229.72	239.29	248.86	258.43	268.00	277.57	287.15
35	152.14	162.29	172.43	182.57	192.71	202.86	213.00	223.14	233.28	243.43	253.57	263.71	273.86	284.00	294.14	304.28
36	160.96	171.69	182.42	193.15	203.88	214.61	225.34	236.08	246.81	257.54	268.27	279.00	289.73	300.46	311.19	321.92
37	170.03	181.36	192.70	204.03	215.37	226.70	238.04	249.37	260.71	272.04	283.38	294.71	306.05	317.38	328.72	340.05
38	179.34	191.30	203.25	215.21	227.17	239.12	251.08	263.03	274.99	286.95	298.90	310.86	322.81	334.77	346.73	358.68
39	188.90	201.50	214.09	226.69	239.28	251.87	264.47	277.06	289.65	302.25	314.84	327.43	340.03	352.62	365.22	377.81
40	198.72	211.96	225.21	238.46	251.71	264.96	278.20	291.45	304.70	317.95	331.19	344.44	357.69	370.94	384.19	397.43
41	208.78	222.69	236.61	250.53	264.45	278.37	292.29	306.21	320.12	334.04	347.96	361.88	375.80	389.72	403.63	417.55
42	219.08	233.69	248.30	262.90	277.51	292.11	306.72	321.32	335.93	350.54	365.14	379.75	394.35	408.96	423.56	438.17
43	229.64	244.95	260.26	275.57	290.88	306.19	321.50	336.81	352.12	367.43	382.74	398.05	413.35	428.66	443.97	459.28
44	240.45	256.48	272.51	288.54	304.57	320.60	336.63	352.66	368.69	384.71	400.74	416.77	432.80	448.83	464.86	480.89
45	251.50	268.27	285.03	301.80	318.57	335.33	352.10	368.87	385.63	402.40	419.17	435.93	452.70	469.47	486.23	503.00
46	262.80	280.32	297.84	315.36	332.88	350.40	367.92	385.44	402.96	420.48	438.00	455.52	473.04	490.56	508.08	525.60
47	274.35	292.64	310.93	329.22	347.51	365.80	384.09	402.38	420.67	438.96	457.25	475.54	493.84	512.13	530.42	548.71
48	286.15	305.23	324.31	343.38	362.46	381.54	400.61	419.69	438.77	457.84	476.92	496.00	515.07	534.15	553.23	572.30
49	298.20	318.08	337.96	357.84	377.72	397.60	417.48	437.36	457.24	477.12	497.00	516.88	536.76	556.64	576.52	596.40
50	310.49	331.19	351.89	372.59	393.29	413.99	434.69	455.39	476.09	496.79	517.49	538.19	558.89	579.59	600.29	620.99

(The values which are in darker region are within the range of observed data)

Table 9 Carbon (kg/tree) for *Betula alnoides* (>50 cm diameter class)

Diameter at breast height (cm)	Height (m)																				
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	285.03	304.04	323.04	342.04	361.04	380.05	399.05	418.05	437.05	456.05	475.06	494.06	513.06	532.06	551.07	570.07	589.07	608.07	627.07	646.08	665.08
52	296.32	316.08	335.83	355.59	375.34	395.09	414.85	434.60	454.36	474.11	493.87	513.62	533.38	553.13	572.89	592.64	612.40	632.15	651.91	671.66	691.42
53	307.83	328.35	348.87	369.39	389.92	410.44	430.96	451.48	472.00	492.52	513.05	533.57	554.09	574.61	595.13	615.66	636.18	656.70	677.22	697.74	718.26
54	319.55	340.86	362.16	383.46	404.77	426.07	447.37	468.68	489.98	511.29	532.59	553.89	575.20	596.50	617.80	639.11	660.41	681.71	703.02	724.32	745.62
55	331.50	353.60	375.70	397.80	419.90	442.00	464.10	486.20	508.30	530.40	552.50	574.60	596.70	618.80	640.90	663.00	685.10	707.20	729.30	751.40	773.50
56	343.66	366.57	389.48	412.39	435.31	458.22	481.13	504.04	526.95	549.86	572.77	595.68	618.59	641.50	664.41	687.32	710.24	733.15	756.06	778.97	801.88
57	356.05	379.78	403.52	427.25	450.99	474.73	498.46	522.20	545.94	569.67	593.41	617.15	640.88	664.62	688.36	712.09	735.83	759.56	783.30	807.04	830.77
58	368.65	393.22	417.80	442.38	466.95	491.53	516.11	540.68	565.26	589.84	614.41	638.99	663.57	688.14	712.72	737.30	761.87	786.45	811.03	835.60	860.18
59	381.47	406.90	432.33	457.76	483.19	508.63	534.06	559.49	584.92	610.35	635.78	661.21	686.65	712.08	737.51	762.94	788.37	813.80	839.23	864.66	890.10
60	394.51	420.81	447.11	473.41	499.71	526.01	552.31	578.62	604.92	631.22	657.52	683.82	710.12	736.42	762.72	789.02	815.32	841.62	867.92	894.22	920.52
61	407.77	434.96	462.14	489.32	516.51	543.69	570.88	598.06	625.25	652.43	679.62	706.80	733.99	761.17	788.36	815.54	842.73	869.91	897.09	924.28	951.46
62	421.25	449.33	477.42	505.50	533.58	561.67	589.75	617.83	645.92	674.00	702.08	730.17	758.25	786.33	814.42	842.50	870.58	898.67	926.75	954.83	982.92
63	434.95	463.94	492.94	521.94	550.93	579.93	608.93	637.92	666.92	695.92	724.91	753.91	782.91	811.90	840.90	869.90	898.89	927.89	956.89	985.88	1014.88
64	448.87	478.79	508.71	538.64	568.56	598.49	628.41	658.34	688.26	718.18	748.11	778.03	807.96	837.88	867.81	897.73	927.65	957.58	987.50	1017.43	1047.35
65	463.00	493.87	524.74	555.60	586.47	617.34	648.20	679.07	709.94	740.80	771.67	802.54	833.40	864.27	895.14	926.00	956.87	987.74	1018.60	1049.47	1080.34
66	477.36	509.18	541.01	572.83	604.65	636.48	668.30	700.12	731.95	763.77	795.60	827.42	859.24	891.07	922.89	954.72	986.54	1018.36	1050.19	1082.01	1113.83
67	491.93	524.73	557.52	590.32	623.11	655.91	688.71	721.50	754.30	787.09	819.89	852.68	885.48	918.27	951.07	983.87	1016.66	1049.46	1082.25	1115.05	1147.84
68	506.73	540.51	574.29	608.07	641.85	675.64	709.42	743.20	776.98	810.76	844.54	878.33	912.11	945.89	979.67	1013.45	1047.24	1081.02	1114.80	1148.58	1182.36
69	521.74	556.52	591.31	626.09	660.87	695.65	730.44	765.22	800.00	834.78	869.57	904.35	939.13	973.91	1008.70	1043.48	1078.26	1113.05	1147.83	1182.61	1217.39
70	536.97	572.77	608.57	644.37	680.17	715.96	751.76	787.56	823.36	859.16	894.95	930.75	966.55	1002.35	1038.15	1073.95	1109.74	1145.54	1181.34	1217.14	1252.94

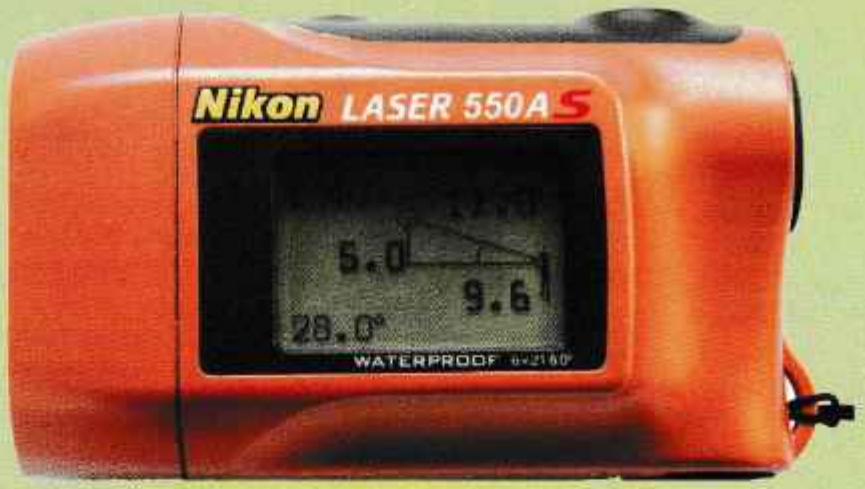
(The values which are in darker region are within the range of observed data)

Table 10 Volume, biomass and carbon table for *Betula alnoides* (DBH 10 -51 cm)

DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)	DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)
10	0.068	39.04	19.52	31	0.603	345.37	172.68
11	0.082	47.24	23.62	32	0.642	368.01	184.01
12	0.098	56.22	28.11	33	0.683	391.37	195.69
13	0.115	65.98	32.99	34	0.725	415.45	207.72
14	0.134	76.53	38.26	35	0.768	440.25	220.12
15	0.153	87.85	43.92	36	0.813	465.76	232.88
16	0.174	99.95	49.98	37	0.859	492.00	246.00
17	0.197	112.84	56.42	38	0.906	518.95	259.48
18	0.221	126.50	63.25	39	0.954	546.63	273.31
19	0.246	140.95	70.47	40	1.004	575.02	287.51
20	0.273	156.18	78.09	41	1.054	604.13	302.06
21	0.300	172.19	86.09	42	1.106	633.96	316.98
22	0.330	188.97	94.49	43	1.160	664.50	332.25
23	0.360	206.54	103.27	44	1.214	695.77	347.89
24	0.392	224.89	112.45	45	1.270	727.76	363.88
25	0.426	244.03	122.01	46	1.327	760.46	380.23
26	0.461	263.94	131.97	47	1.385	793.88	396.94
27	0.497	284.63	142.32	48	1.445	828.02	414.01
28	0.534	306.11	153.05	49	1.506	862.88	431.44
29	0.573	328.36	164.18	50	1.568	898.46	449.23
30	0.613	351.40	175.70	51	1.583	907.04	453.52

Table 11 Volume, biomass and carbon table for *Betula alnoides* (DBH 51-100 cm)

DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)	DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)
51	1.583	907.04	453.52	76	3.515	2014.25	1007.13
52	1.646	942.96	471.48	77	3.608	2067.61	1033.80
53	1.710	979.58	489.79	78	3.703	2121.66	1060.83
54	1.775	1016.89	508.45	79	3.798	2176.41	1088.21
55	1.841	1054.90	527.45	80	3.895	2231.86	1115.93
56	1.909	1093.61	546.81	81	3.993	2288.00	1144.00
57	1.977	1133.02	566.51	82	4.092	2344.85	1172.42
58	2.047	1173.12	586.56	83	4.193	2402.39	1201.19
69	2.119	1213.92	606.96	84	4.294	2460.62	1230.31
60	2.191	1255.42	627.71	85	4.397	2519.56	1259.78
61	2.265	1297.62	648.81	86	4.501	2579.19	1289.60
62	2.339	1340.51	670.25	87	4.606	2639.52	1319.76
63	2.416	1384.10	692.05	88	4.713	2700.55	1350.27
64	2.493	1428.39	714.19	89	4.821	2762.27	1381.14
65	2.571	1473.37	736.69	90	4.930	2824.70	1412.35
66	2.651	1519.06	759.53	91	5.040	2887.81	1443.91
67	2.732	1565.44	782.72	92	5.151	2951.63	1475.82
68	2.814	1612.52	806.26	93	5.264	3016.15	1508.07
69	2.898	1660.29	830.15	94	5.378	3081.36	1540.68
70	2.982	1708.77	854.38	95	5.493	3147.27	1573.63
71	3.068	1757.94	878.97	96	5.609	3213.88	1606.94
72	3.155	1807.80	903.90	97	5.726	3281.18	1640.59
73	3.243	1858.37	929.19	98	5.845	3349.18	1674.59
74	3.333	1909.63	954.82	99	5.965	3417.88	1708.94
75	3.423	1961.59	980.80	100	6.086	3487.28	1743.64



Nikon Laser 550A Range Finder : Used for measurement of total tree height, height at the occurrence of first branch of each individual tree and length of frustum.



Mantax Black Calliper with Gator Eyes, Make : Haglof Sweden : Used for measurement of diameter from a distance with laser beam (diameter measurement at different height of each tree)

Summary

Betula alnoides (Himalayan Birch) is a tree commonly found in Meghalaya and extracted for commercial purpose. The report provides the volume tables and biomass tables of the utilizable stem portion, for use by the forest department, community and dealers in timber. The information on equivalent carbon content is also provided. This is a major component of the above ground biomass and can be used in projects related to carbon trading.

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