EVALUATION OF CARBON CONTENT IN FORESTS OF NORTH EASTERN MEXICO

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Abstract

The acknowledgement of the importance of environmental services that forests provide and the need to count on reliable methods to assess them are the reasons to accomplish the actual study, whose objectives were to develop methods and practical tools to estimate the carbon content of some forest types. Better knowdledge of carbon stocks and fluxes is needed to understand the current state of the carbon cycle and how it might envolve with changing land uses and climatic conditions. Aboveground tree mass is estimated using allometric equations relating diameter at breast height to total tree mass or component parts of bole wood, branch, and foliage mass. In the present work biomass equations in function of the normal diameter with a form of $b= \beta_1 * d^2$ for *Pinus pseudostrobus*, *P. teocote* and *Quercus* spp. were developed in temperate forests of North Eastern Mexico. Likewise, the carbon content of the species was determined with an organic carbon analyzer. The results allowed the construction of biomass and carbon content tarif tables and charts, through which contained carbon in tree species of mixed forests pine-oak, oak-pine and pure pine stands was evaluated. The carbon percentage in *Pinus pseudostrobus* was 50.35, in *P. teocote* 47.78 and in *Quercus* spp. 48.43. Carbon content tables for pure pine stands of the two pine species were built for different site indices. The results of the carbon content evaluation in different types of forest were: pine-oak forest 45.24 Mg/ha, oak-pine forest 64.20 Mg/ha, pure pine forest of *P. pseudostrobus* 73.18 Mg/ha and *P. teocote* forest 47.01 Mg/ha. Two inventory techniques for the estimation of forest carbon in different forest structures are discussed, and field measurement guidelines for mixed and pure stands are presented. Our objective is to communicate some initial lessons about the practical challenges of designing and conducting measurements of carbon pools in Mexico.

Study area

Field work was made in pure stands of *Pinus pseudostrobus* Lindl. and *P. teocote* Schied. ex Schltdl. et Cham forests, as well as in mixed forests of pine-oak or oak-pine of Sierra Madre Oriental in North Eastern Mexico. The area is located between 24°27'23'' and 24°32'51'' North and 99°53'54'' and 100°01'34'' West, in the municipality of Galeana, South Nuevo Leon.

Results

Table 1. Biomass and carbon content estimating rate.

Diametric Category (cm)	*Pinus pseudostrobus*		*P. teocote*		*Quercus* spp.	
	Biomass (kg)	Carbon (kg)	Biomass (kg)	Carbon (kg)	Biomass (kg)	Carbon (kg)
5	8.79	4.43	10.05	4.80	11.38	5.51
10	35.18	17.71	40.20	19.21	45.53	22.05
15	79.15	39.85	90.44	43.21	102.45	49.62
20	140.72	70.85	160.78	76.82	182.14	88.21
25	219.87	110.70	251.23	120.04	284.59	137.83
30	316.61	159.41	361.76	172.85	409.81	198.47
35	430.94	216.98	492.40	235.27	557.79	270.14
40	562.86	283.40	643.14	307.29	728.54	352.83
45	712.37	358.68	813.97	388.91	922.06	446.56
50	879.48	442.82	1004.90	480.14	1138.35	551.30
55	1064.16	535.81	1215.93	580.97	1377.40	667.08
60	1266.44	637.65	1447.06	691.40	1639.22	793.88

Table 2. Biomass and carbon content table for *Pinus pseudostrobus*, IS 21.

Age (years)	N ha^{-1}	Diameter (cm)	Basal area (m^2)	Biomass ha^{-1} (ton)	Carbon ha^{-1} (ton)
10	4240	6.5	13.9	63.02	31.73
15	1929	12.4	23.1	104.34	52.54
20	1233	17.6	30	134.36	67.65
25	915	22.2	35.1	158.64	79.87
30	738	26	39.1	175.50	88.37
35	625	29.3	42.3	188.76	95.04
40	548	32.2	44.8	199.88	100.64
45	491	34.9	46.9	210.39	105.93
50	449	37.1	48.6	217.41	109.47
55	415	39.2	50.1	224.34	112.95
60	387	41.1	51.3	229.97	115.79
65	365	42.7	52.4	234.12	117.88

Table 3. Biomass and carbon content table for *Pinus teocote*, IS 21.

Age (years)	N ha^{-1}	Diameter (cm)	Basal area (m^2)	Biomass ha^{-1} (ton)	Carbon ha^{-1} (ton)
7	2885	6.6	9.7	50.51	24.14
10	1922	8.5	11	55.82	26.67
15	1235	11.8	13.6	69.12	33.03
20	914	15.1	16.3	83.77	40.02
25	728	18.3	19.1	98.00	46.82
30	608	21.4	21.9	111.92	53.48
35	524	24.4	24.5	125.40	59.92
40	461	27.3	27.1	138.10	65.99
45	414	30.1	29.5	150.77	72.04
50	376	32.8	31.8	162.60	77.69
55	346	35.4	34	174.29	83.27
60	321	37.8	36	184.36	88.09
65	300	40.1	37.9	193.91	92.65

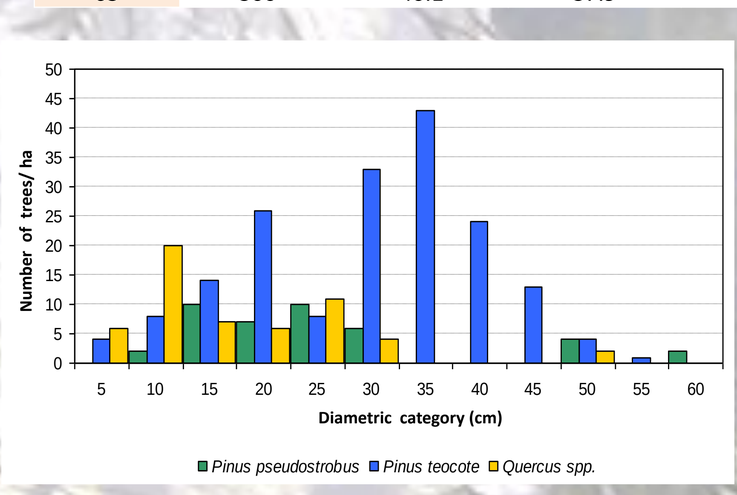

Figure 1. Pine-oak mixed forest structure .

Table 4. Carbon content in a pine-oak mixed forest.

Diametric Category (cm)	*Pinus teocote*			*P. pseudostrobus*			*Quercus* spp.		
	N ha^{-1}	Biomass (ton)	Carbon (ton)	N ha^{-1}	Biomass (ton)	Carbon (ton)	N ha^{-1}	Biomass (ton)	Carbon (ton)
5	4						6		
10	8	0.32	0.15	2	0.07	0.04	20	0.91	0.44
15	14	1.27	0.60	10	0.79	0.40	7	0.72	0.35
20	26	4.18	2.00	7	0.99	0.50	6	1.09	0.53
25	8	2.01	0.96	10	2.20	1.11	11	3.13	1.52
30	33	11.94	5.70	6	1.90	0.96	4	1.64	0.79
35	43	21.17	10.12						
40	24	15.44	7.37						
45	13	10.58	5.06						
50	4	4.02	1.92	4	3.52	1.77	2	2.28	1.10
55	1	1.22	0.58			0.00			
60				2	2.53	1.28			
Total	178	72.14	34.47	41	12.00	6.04	56	9.77	4.73

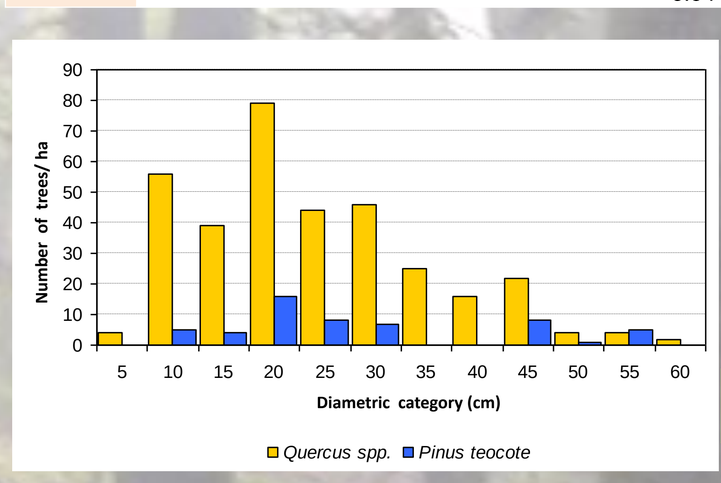

Figure 4. Oak-pine mixed forest structure.

Table 5. Carbon content in an oak-pine mixed forest.

Diametric Category (cm)	*Quercus* spp.			*Pinus teocote*		
	N ha^{-1}	Biomass (ton)	Carbon (ton)	N ha^{-1}	Biomass (ton)	Carbon (ton)
5	4	0.05	0.02			
10	56	2.55	1.23	5	0.20	0.10
15	39	4.00	1.94	4	0.36	0.17
20	79	14.39	6.97	16	2.57	1.23
25	44	12.52	6.06	8	2.01	0.96
30	46	18.85	9.13	7	2.53	1.21
35	25	13.94	6.75			
40	16	11.66	5.65			
45	22	20.29	9.82	8	6.51	3.11
50	4	4.55	2.21	1	1.00	0.48
55	4	5.51	2.67	5	6.08	2.90
60	2	3.28	1.59			
Total	341	111.58	54.04	54	21.27	10.16

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