Supplementary information for: Carbon stocks in aboveground biomass for Colombian mangroves with associated uncertainties

Jhoanata M. Bolivar[a,b], Victor H. Gutierrez-Velez[c,b], Carlos A. Sierra[a,b]

[a] *Max Planck Institute for Biogeochemistry, Hans-Knöll-Str. 10, 07745 Jena, Germany*
[b] *Research Center on Ecosystems and Global Change Carbono & Bosques, Medellín, Colombia*
[c] *Department of Geography and Urban Studies, Temple University, Philadelphia, PA 19122, USA*

This supplementary material contains two tables. The first table presents all sources of information on AGB density used for estimation of national C stocks and model development. The second table presents all the statistical models tested in our analysis with corresponding results from statistical tests.

Table 1: Data sources of Aboveground biomass (AGB) used to estimation of total AGB carbon stock in Colombian mangroves and development of predictive models.

Department	Coast	Location	Coordinates		AGB	Source
			X	Y	(Mg ha-1)	
La Guajira	Caribbean	Brazo Riito-Ranchería river delta	-72.8931	11.5578	70.98	Lema and Polanía (2007)
La Guajira	Caribbean	Valle de los cangrejos-Ranchería river delta	-72.8914	11.5588	26.78	Lema and Polanía (2007)
Magdalena	Caribbean	CGSM-Rinconada	-74.4938	10.9615	91.40	De la Peña et al. (2010)
Magdalena	Caribbean	CGSM-Aguas Negras	-74.6075	10.8089	16.10	De la Peña et al. (2010)
Magdalena	Caribbean	CGSM-Caño Grande	-74.4814	10.8619	75.80	De la Peña et al. (2010)
Magdalena	Caribbean	CGSM-Luna	-74.938	10.9071	13.80	De la Peña et al. (2010)
Magdalena	Caribbean	Chengue bay- Tayrona NNP	-74.1284	11.3178	132.10	INVEMAR (2007)
Córdoba	Caribbean	Cispatá bay-Caño Tijó 1	-75.8378	9.3566	147.50	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Tijó 2	-75.8284	9.3606	186.60	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Palermo	-75.8423	9.3525	129.70	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Grande 1	-75.8505	9.3712	153.20	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-El Claval	-75.7912	9.3874	80.20	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Garzal 1	-75.8563	9.382	122.80	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Garzal 2	-75.8588	9.3811	159.30	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-La Flotante-Caño Nisperal	-75.8029	9.3906	90.40	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Vertel-Caño el Nene	-75.8397	9.3823	151.20	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Salado 1	-75.8721	9.4155	131.70	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Ciénaga Galo	-75.8266	9.3673	101.80	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Ostional	-75.8639	9.3961	89.30	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-La Zona, Rincón el grillo	-75.8384	9.397	72.00	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-La Camaronera	-75.7914	9.3844	74.00	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Ciénaga Remediapobres	-75.8435	9.3679	133.20	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Ciénaga Soledad	-75.8464	9.3407	171.40	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Garzal 3	-75.8447	9.3954	102.10	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Grande 2	-75.854	9.3690	220.80	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Jesús Primera	-75.8439	9.3784	128.50	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño Salado 2	-75.8276	9.4183	69.30	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Angostura	-75.5885	9.4221	246.90	Bolivar et al. (In preparation)
Córdoba	Caribbean	Cispatá bay-Caño el Soldado	-75.8548	9.3557	77.70	Bolivar et al. (In preparation)
Antioquia	Caribbean	Atrato river delta	-77.1005	8.0508	178.60	Blanco et al. (2012)
Antioquia	Caribbean	Puerto Cesar - Punta Coquito	-76.7407	7.9592	41.60	Blanco et al. (2012)
Antioquia	Caribbean	Punta Yarumal-Punta Las Vacas	-76.7478	8.1111	61.60	Blanco et al. (2012)
Antioquia	Caribbean	Punta Yarumal-Punta Las Vacas 2	-76.7478	8.1111	35.00	Blanco et al. (2012)
Antioquia	Caribbean	Rionegro cove 1	-76.9292	8.5458	21.20	Blanco et al. (2012)
Antioquia	Caribbean	Rionegro cove 2	-76.9292	8.5458	43.80	Blanco et al. (2012)
Antioquia	Caribbean	Rionegro cove 3	-76.9292	8.5458	30.80	Blanco et al. (2012)
Valle del Cauca	Pacific	Málaga bay-Luisico	-77.2148	4.0678	109.60	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Luisico-Winul	-77.2055	4.0842	45.30	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Luisico-Cangrejal	-77.2051	4.0874	295.90	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-El Morro-Aserrío	-77.1927	4.0506	4.00	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Corozal	-77.2678	4.0805	63.40	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Gegenera	-77.266	4.0543	51.00	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Valencia	-77.2523	4.1069	184.90	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-La Estancia	-77.2714	4.1035	77.00	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Mayordomo-Manglar blanquito	-77.301	4.0420	107.50	Carbono & Bosques (2015)
Valle del Cauca	Pacific	Málaga bay-Caracas	-77.268	3.9871	117.20	Carbono & Bosques (2015)

Table 2: Statistical regression models tested in our analysis. AGB represents aboveground biomass (Mg/ha); BIO9 is the mean temperature of driest quarter (℃); BIO10 mean temperature of warmest quarter (℃); BIO11 mean temperature of coldest quarter (℃); BIO16 is the precipitation of the wettest quarter (mm); EVI is the enhanced vegetation index; Lat is the absolute value of latitude (decimal degrees); n is the number of observations; $R_a{}^2$ is the adjusted coefficient of determination; MSE is the mean squared error; F is the F-statistic calculated; AIC is Akaike's information criterion

Model	n	$R_a{}^2$	MSE	F	AIC
(1) $AGB = -2.210^{e+03} + 2.946^{e+00} BIO10 + 4.687^{e+00} BIO11 + 2.108^{e-01} BIO16 - 2.334^{e-01} BIO17 + 2.465^{e+02} EVI$	40	0.04163	4157	1.34	454.313
(2) $AGB = -1.876^{e+03} + 7.766^{e+00} BIO1 + 7.64^{e-02} BIO4 + 5.413^{e-03} BIO12 - 2.908^{e-00} BIO15$	43	-0.0278	4338	0.72	488.850
(3) $AGB = -3.260^{e+03} + 1.233^{e+01} BIO1 + 1.61^{e-01} BIO4 + 1.934^{e-02} BIO12 - 3.805^{e+00} BIO15 + 2.835^{e+02} EVI$	40	0.07695	4003	1.65	452.811
(4) $AGB = -1.920^{e+03} - 7.292^{e+01} Lat + 7.878^{e+00} BIO10 + 1.846^{e+00} BIO11 - 1.115^{e-01} BIO16 + 2.404^{e-02} BIO17 + 1.561^{e-02} EVI$	40	0.1288	3779	1.961	451.303
(5) $AGB = -1.372^{e+03} + 6.358^{e+00} BIO10 + 1.789^{e+00} BIO11 - 7.389^{e-02} BIO16 - 1.229^{e-01} BIO17 - 7.746^{e+01} Lat$	43	0.154	3571	2.529	481.333
(6) $AGB = -1.286^{e+03} - 9.594^{e+01} Lat + 8.621^{e+00} BIO1 + 1.161^{e-01} BIO4 - 6.145^{e-02} BIO12 - 4.687^{e-01} BIO15$	43	0.1819	3453	2.868	479.891
(7) $AGB = -2.219^{e+03} - 7.703^{e+01} Lat + 1.113^{e+00} BIO1 + 1.885^{e-01} BIO4 - 4.071^{e-02} BIO12 - 1.735^{e-01} BIO15 + 1.813^{e+02} EVI$	41	0.1762	3573	2.39	449.069
(8) $AGB = 35338.8860 - 155.9330\lvert Lat\rvert - 2490.0405 \frac{BIO1}{10} + 49.1282(\frac{BIO1}{10})^2 - 85.6399 \frac{BIO11}{10} - 0.1171 BIO12 + 0.4483 BIO15$	43	0.1975	3387	2.72	479.882
(9) $AGB = 2.546^{e+04} - 1.337^{e+02} \lvert Lat\rvert - 1.653^{e+03} \frac{BIO1}{10} + 3.743^{e+01} (\frac{BIO1}{10})^2 - 2.499^{e+02} \frac{BIO11}{10} - 9.722^{e-02} BIO12 - 2.508^{e+00} BIO15 + 2.422^{e-02} EVI$	40	0.3627	3369	2.60	447.478
(10) $AGB = -1916.5321 + 7.3424 BIO9 + 0.1126 BIO17$	43	0.1456	3607	4.58	479.110
(11) $AGB = -1.693^{e+03} - 2.897^{e+01} Lat + 7.567^{e+00} BIO9 - 4.108^{e-02} BIO17$	43	0.2072	3346	4.66	476.801
(12) $AGB = -2.391^{e+03} - 9.020^{e+00} Lat + 9.087^{e+00} BIO9 + 1.105^{e-01} BIO17 + 1.695^{e-02} EVI$	43	0.1898	3514	3.284	446.756
(13) $AGB = -1.855^{e+03} - 2.390^{e+01} Lat + 7.809^{e+00} 1 BIO9 + 9.615^{e-03} EVI$	40	0.2001	3469	4.25	445.371
(14) $AGB = -3.232^{e+02} + 1.499^{e+00} BIO9 + 5.1442 EVI$	40	-0.01318	4394	0.75	453.920
(15) $AGB = -1860.211 + 7.958 BIO9 - 22.944 Lat$	43	0.2225	3282	7.01	475.052
(16) $AGB = -423.235 + 1.943 BIO9$	43	0.01697	4149	1.72	484.202
(17) $AGB = -1.1408^{e+03} - 9.370^{e+00} BIO11 + 3.327^{e-02} BIO16 + 1.348^{e+01} BIO9 + 1.065^{e-02} EVI$	40	0.2082	3434	3.56	445.835
(18) $AGB = -2.670^{e+03} + 9.671^{e+00} BIO11 + 1.008^{e-01} BIO16 + 2.298^{e-02} EVI$	40	0.06889	4038	1.96	451.446
(19) $AGB = -822.9927 + 3.0227 BIO11 + 0.2433 BIO16 - 0.4077 BIO17$	43	0.04791	4019	1.70	484.676
(20) $AGB = -835.18954 - 20.28373 BIO11 + 0.02986 BIO16 + 14.30146 BIO9 + 8.635535 BIO1 + 0.01895 EVI$	40	0.2143	3408	3.13	446.366
(21) $AGB = 3.451^{e+04} - 2.302^{e+02} \frac{BIO11}{10} - 8.086^{e-03} BIO16 + 2.071^{e+02} \frac{BIO9}{10} 2.549^{e+03} \frac{BIO1}{10} + 4.777^{e+01} (\frac{BIO1}{10})^2 + 2.018^{e-02} EVI$	40	0.2309	3336	2.95	446.319
(22) $AGB = -9.327^{e+02} + 1.846^{e-03} BIO10^2 + 1.132^{e-02} BIO11^2 + 1.476^{e-05} BIO16^2 + 5.747^{e-05} BIO17^2 + 2.556^{e-06} EVI^2$	40	0.04177	4518	0.69	457.651
(23) $\log AGB = -249.0196 + 23.8766 \log BIO10 + 17.2434 \log BIO11 + 1.3926 \log BIO16 + 0.2169 \log BIO17 + 1.5243 \log EVI$	40	0.1954	0.614	2.89	101.484
(24) $AGB = -17786.59 + 1487.86 \log BIO10 + 1428.78 \log BIO11 + 115.81 \log BIO16 + 12.94 \log BIO17 + 87.21 \log EVI$	40	0.08968	3948	1.77	452.256
(25) $\log AGB = -191.3654 + 32.0857 \log BIO9 + 1.1316 \log BIO16 + 1.0113 \log EVI$	40	0.3028	0.532	6.65	94.038
(26) $\log AGB = -94.7756 + 21.9228 \log BIO9 - 3.2190 \log BIO16 + 0.8363 \log EVI - 1.1157\lvert Lat\rvert$	40	0.3586	0.489	6.45	91.573
(27) $\log AGB = -18.7623 + 39.9688 \log BIO9 - 3.0771 \log BIO16 + 0.7138 \log EVI - 0.8834\lvert Lat\rvert - 32.0563 \log BIO11$	40	0.353	0.493	5.26	92.761
(28) $AGB = 2071.2 - 569777.6 \frac{1}{BIO9} + 20516.4 \frac{1}{BIO16} - 333815.1 \frac{1}{EVI} + 1377.2 \frac{1}{\lvert Lat\rvert}$	40	0.2631	3196	4.48	442.959
(29) $\frac{1}{AGB} = 9.895^{e-01} - 2.836^{e-03} BIO9 - 4.386^{e-05} BIO16 - 1.638^{e-05} EVI - 9.419^{e-03} \lvert Lat\rvert$	40	0.1415	0.0014	2.61	-143.157
(30) $\frac{1}{AGB} = -0.4451 + 154.8629 \frac{1}{BIO9} - 49.9774 \frac{1}{BIO16} + 388.4439 \frac{1}{EVI} - 0.8805 \frac{1}{\lvert Lat\rvert}$	40	0.5587	0.0007	13.34	-169.773
(31) $\log AGB = -68.661 + 21.023 \log BIO9 - 5.397 \log BIO16 + 1.842 \log EVI - 11.790 \log \lvert Lat\rvert$	40	0.4507	0.419	9.00	85.375
(32) $\log AGB = -2.889^{e+01} + 1.217^{e-01} \log BIO9 + 4.858^{e-04} \log BIO16 + 2.457^{e-04} \log EVI - 1.613^{e-01} \lvert Lat\rvert$	40	0.2641	0.561	4.50	97.073
(33) $AGB = -6880.48 + 1646.40 \log BIO9 - 262.05 \log BIO16 + 98.26 \log EVI - 639.37 \log \lvert Lat\rvert$	40	0.2671	3179	4.55	442.745
(34) $AGB = -3707.820 + 256.857 \sqrt{BIO9} - 1.560 \sqrt{BIO16} + 1.600 \sqrt{EVI} - 166.952 \sqrt{\lvert Lat\rvert}$	40	0.1981	3478	3.41	446.345
(35) $\sqrt{AGB} = -1.202^{e+02} + 4.813^{e-01} BIO9 - 1.923^{e-03} BIO16 + 8.131^{e-04} EVI - 7.431^{e-01} \lvert Lat\rvert$	40	0.2531	8.62	4.30	206.338
(36) $\log AGB = 32.568 - 8256.480 \frac{1}{BIO9} + 572.760 \frac{1}{BIO16} - 6457.220 \frac{1}{EVI} + 21.747 \frac{1}{\lvert Lat\rvert}$	40	0.4675	0.406	9.56	84.130
(37) $AGB = -1.855^{e+03} + 7.809^{e+00} BIO9 + 9.615^{e-03} EVI - 2.390^{e+01} \lvert Lat\rvert$	40	0.2001	3469	4.25	445.371
(38) $\log AGB = -183.9219 + 32.6554 \log BIO9 + 1.2009 \log EVI - 2.2817 \log \lvert Lat\rvert$	40	0.3572	0.490	8.22	90.790
(39) $\log AGB = -2.532^{e+01} + 1.156^{e-01} BIO9 + 1.906^{e-04} EVI - 3.007^{e-01} \lvert Lat\rvert$	40	0.2807	0.549	6.07	95.288
(40) $AGB = -12476.98 + 2211.21 \log BIO9 + 67.12 \log EVI - 177.67 \log \lvert Lat\rvert$	40	0.2423	3286	5.16	443.200
(41) $AGB = -3980.6149 + 264.1664 \sqrt{BIO9} + 1.7156 \lvert sqrt EVI - 132.2929 \sqrt{\lvert Lat\rvert}$	40	0.2199	3383	4.66	444.367
(42) $\sqrt{AGB} = -1.061^{e+02} + 4.570^{e-01} BIO9 + 5.950^{e-04} EVI - 1.295^{e+00} \lvert Lat\rvert$	40	0.2699	8.430	5.80	204.556
(43) $\log AGB = 36.254 - 8845.587 \frac{1}{BIO23} - 5303.932 \frac{1}{EVI} + 15.133 \frac{1}{\lvert Lat\rvert}$	40	0.4507	0.419	11.67	84.502
(44) $\log AGB = 12.977 - 2107.057 \frac{1}{BIO9} - 3371.758 \frac{1}{EVI}$	40	0.1931	0.615	5.67	98.980
(45) $\log AGB = -751.4362 + 8.8199 \log BIO9 + 0.7639 \log EVI$	40	0.1312	0.6626	3.94	101.936
(46) $\log AGB = -6.0469510 + 0.0361823 BIO9 + 0.0001344 EVI$	40	0.08879	0.695	2.90	103.843
(47) $\sqrt{AGB} = -2.311^{e+01} + 1.151^{e-01} BIO9 + 3.528^{e-04} EVI$	40	0.03062	11.188	1.62	214.990
(48) $\log AGB = 27.758 - -5876.246 \frac{1}{BIO9} - 3042.594 \frac{1}{BIO16} - 610.758 \frac{1}{EVI}$	40	0.2675	0.559	5.75	96.015

References

Blanco, J. F., Estrada, E. a., Ortiz, L. F., Urrego, L. E., 2012. Ecosystem-Wide Impacts of Deforestation in Mangroves: The Urabá Gulf (Colombian Caribbean) Case Study. ISRN Ecology 2012, 1–14.

Bolivar, J., Yepes, A., Sierra, C. A., Urrego, L., Moreno, F., Monsalve, A., Espinosa, S., Agudelo, C., Betancur, S., Posada, J., Herrera, D., Mira, J., Sierra-Correa, P., In preparation. Carbon stock in mangroves of cispatá delta estuarine system., in preparation.

Carbono & Bosques, 2015. Caracterización de la estructura y contenido de carbono de diez parcelas permanentes establecidas en el área de jurisdicción del consejo comunitario la plata, bahía málaga, valle del cauca. Tech. rep., INVEMAR-Fundación Natura.

De la Peña, A., Rojas, C. A., De la Peña, M., 2010. Valoración económica del manglar por el almacenamiento de carbono ,. Clío America 4 (7), 133–150.

INVEMAR, 2007. Informe del Estado de los Recursos Marinos y Costeros en Colombia: Año 2006. Tech. rep., Instituto de investigaciones Marinas y Costeras "José Benito Vives de Andréis".

Lema, L. F., Polanía, J., 2007. Estructura y dinámica del manglar del delta del río Ranchería , Caribe colombiano. Revista de Biología Tropical 55 (1), 11–21.