1. **Supplementary Table 2 | Africa’s mangrove canopy height, aboveground biomass (AGB),**
2. **and carbon estimates based on region-specific allometric equations.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Country** | **Max height (m)** | **Mean height (m)** | **Max AGB**  **(Mg ha-1)** | **Mean AGB**  **(Mg ha-1)** | **Total AGB (Mg)** | **Total carbon (Mg)** | **Total area (ha)** |
| 1 | Gabon | 62.8 | 23.5 | 910.5 | 244.0 | 33,578,276 | 61,504,323 | 137,597 |
| 2 | Equatorial Guinea | 57.7 | 21.6 | 800.0 | 208.6 | 2,630,892 | 5,337,399 | 12,613 |
| 3 | Cameroon | 47.5 | 22.6 | 594.5 | 208.7 | 41,603,704 | 84,360,030 | 199,303 |
| 4 | Angola | 45.8 | 16.6 | 562.3 | 139.7 | 3,738,534 | 10,090,736 | 26,779 |
| 5 | Cote d'Ivoire | 44.1 | 16.1 | 530.8 | 130.4 | 249,076 | 708,115 | 1,911 |
| 6 | Liberia | 37.3 | 13.2 | 411.1 | 97.0 | 724,245 | 2,599,351 | 7,465 |
| 7 | Nigeria | 33.9 | 13.4 | 355.3 | 96.5 | 66,791,716 | 240,715,439 | 691,986 |
| 8 | Comoros | 32.2 | 19.2 | 658.0 | 246.7 | 26,858 | 48,867 | 109 |
| 9 | Democratic Rep. of Congo | 30.5 | 10.9 | 302.4 | 68.8 | 1,396,076 | 6,684,097 | 20,304 |
| 10 | Ghana | 28.8 | 9.4 | 277.1 | 59.8 | 689,229 | 3,724,126 | 11,523 |
| 11 | Sierra Leone | 28.8 | 11.3 | 277.1 | 74.7 | 11,701,745 | 52,204,468 | 156,682 |
| 12 | South Africa | 28.8 | 14.9 | 519.2 | 160.9 | 226,963 | 551,950 | 1,411 |
| 13 | Tanzania | 28.8 | 16.4 | 519.2 | 182.0 | 17,214,904 | 38,347,862 | 94,628 |
| 14 | Madagascar | 27.2 | 14.6 | 456.3 | 146.8 | 39,610,740 | 102,656,269 | 268,686 |
| 15 | Mayotte | 25.5 | 15.3 | 397.7 | 152.1 | 78,149 | 197,952 | 514 |
| 16 | Europa Island | 23.8 | 16.5 | 343.4 | 166.5 | 96,445 | 228,726 | 579 |
| 17 | Reunion and Mauritius | 23.8 | 8.3 | 343.4 | 65.7 | 2,107 | 10,497 | 32 |
| 18 | Guinea | 22.1 | 10.2 | 183.9 | 60.4 | 14,682,286 | 78,699,556 | 243,227 |
| 19 | Seychelles | 22.1 | 13.3 | 293.3 | 114.4 | 124,380 | 391,309 | 1,087 |
| 20 | Togo | 22.1 | 6.8 | 183.9 | 39.3 | 4,894 | 38,560 | 125 |
| 21 | Djibouti | 20.4 | 11.3 | 269.2 | 93.4 | 50,933 | 188,495 | 545 |
| 22 | Guinea Bissau | 20.4 | 11.8 | 162.7 | 71.6 | 24,783,942 | 114,576,720 | 346,015 |
| 23 | Kenya | 20.4 | 8.8 | 247.3 | 55.3 | 1,789,149 | 10,363,775 | 32,373 |
| 24 | Mozambique | 20.4 | 10.6 | 247.3 | 73.9 | 23,639,760 | 106,169,069 | 319,023 |
| 25 | Gambia | 18.7 | 8.1 | 142.4 | 42.0 | 2,932,013 | 21,735,458 | 69,842 |
| 26 | Egypt | 17.0 | 6.6 | 186.7 | 45.1 | 9,502 | 66,810 | 214 |
| 27 | Eritrea | 15.3 | 8.2 | 151.1 | 53.1 | 307,640 | 1,847,310 | 5,797 |
| 28 | Somalia | 15.3 | 6.3 | 134.0 | 30.7 | 78,608 | 777,134 | 2,559 |
| 29 | Senegal | 13.6 | 6.2 | 87.5 | 28.4 | 4,587,751 | 48,735,342 | 161,316 |
| 30 | Mauritania | 10.2 | 6.2 | 56.3 | 29.2 | 814 | 8,450 | 28 |
| 31 | Benin | 8.5 | 3.0 | 42.6 | 10.0 | 47,369 | 1,370,222 | 4,729 |
| 32 | Soudan | 8.5 | 3.4 | 46.5 | 11.0 | 3,551 | 93,902 | 323 |
| 33 | Congo | 0.8 | 1.0 | 1.3 | 1.3 | 445 | 100,260 | 353 |
| 137 |  |  |  |  |  |  |  |  |  |
| 138 |  |  |  |  |  |  |  |  |  |
| 139 |  |  |  |  |  |  |  |  |  |
| 140 |  |  |  |  |  |  |  |  |  |
| 141 |  |  |  |  |  |  |  |  |  |
| 142 |  |  |  |  |  |  |  |  |  |
| 143 |  |  |  |  |  |  |  |  |  |
| 144 |  |  |  |  |  |  |  |  |  |

1. **Supplementary Table 3 | Oceania’s mangrove canopy height, aboveground biomass (AGB),**
2. **and carbon estimates based on region-specific allometric equations.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Country** | **Max height (m)** | **Mean height (m)** | **Max AGB**  **(Mg ha-1)** | **Mean AGB**  **(Mg ha-1)** | **Total AGB (Mg)** | **Total Carbon (Mg)** | **Total area (ha)** |
| 1 | Papua New Guinea | 45.8 | 27.7 | 432.5 | 242.4 | 113,948,576 | 209,577,515 | 469,983 |
| 2 | Micronesia | 40.7 | 21.6 | 366.4 | 189.0 | 1,839,511 | 3,990,518 | 9,733 |
| 3 | New Zealand | 30.5 | 12.3 | 257.3 | 118.6 | 3,669,821 | 11,229,992 | 30,968 |
| 4 | Australia | 25.5 | 11.9 | 212.6 | 119.4 | 112,797,816 | 342,085,251 | 940,941 |
| 5 | Hawaii | 25.5 | 10.6 | 122.6 | 35.6 | 25,154 | 216,808 | 706 |
| 6 | Palau\* | 25.5 | 16.4 | 212.6 | 149.4 | 601,312 | 1,543,040 | 4,025 |
| 7 | Solomon Islands\* | 25.5 | 14.2 | 212.6 | 136.0 | 4,268,817 | 11,753,573 | 31,396 |
| 8 | Vanuatu | 25.5 | 12.1 | 212.6 | 120.3 | 163,396 | 494,188 | 1,358 |
| 9 | Wallis and Futuna | 25.5 | 12.8 | 212.6 | 124.7 | 1,717 | 5,052 | 14 |
| 10 | Samoa\* | 23.8 | 13.0 | 199.0 | 127.2 | 36,766 | 106,538 | 289 |
| 11 | French Polynesia | 22.8 | 18.5 | 191.7 | 161.7 | 176 | 425 | 1 |
| 12 | Fiji\* | 22.1 | 5.5 | 185.9 | 83.5 | 8,344,792 | 33,924,129 | 100,058 |
| 13 | Northern Mariana Islands\* | 21.9 | 14.6 | 184.6 | 133.1 | 98 | 273 | 1 |
| 14 | New Caledonia | 18.7 | 8.0 | 161.5 | 92.1 | 2,198,955 | 8,233,948 | 23,874 |
| 15 | Tuvalu | 17.0 | 4.5 | 150.0 | 76.8 | 585 | 2,549 | 8 |
| 16 | Tonga | 13.6 | 7.0 | 128.5 | 89.9 | 69,344 | 264,770 | 771 |
| 17 | Kiribati | 0.8 | 0.8 | 57.4 | 57.4 | 980 | 5,490 | 17 |
| 18 | Marshall islands | 0.8 | 0.8 | 57.4 | 57.4 | 60 | 334 | 1 |

148

149

150

151

152

153

154

155

156

157

158

159

160

161

162

163

164

165

166

167

168

169

170

171

172

173

\*Maximum canopy height could not be accurately measured due to misclassification of mangrove extent.

1. **Supplementary Table 4 | Asia’s mangrove canopy height, aboveground biomass (AGB), and**
2. **carbon estimates based on region-specific allometric equations.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Country** | **Max height (m)** | **Mean height (m)** | **Max AGB**  **(Mg ha-1)** | **Mean AGB**  **(Mg ha-1)** | **Total AGB (Mg)** | **Total carbon (Mg)** | **Total area (ha)** |
| 1 | Indonesia | 44.1 | 24.3 | 409.5 | 215.3 | 574,318,208 | 1,140,797,712 | 2,667,356 |
| 2 | Brunei | 39.0 | 28.4 | 346.2 | 241.1 | 2,624,305 | 4,843,908 | 10,885 |
| 3 | Malaysia | 33.9 | 19.9 | 290.6 | 172.9 | 95,561,040 | 220,641,786 | 552,741 |
| 4 | Singapore | 33.9 | 16.7 | 290.6 | 152.0 | 86,206 | 218,443 | 567 |
| 5 | Myanmar | 30.5 | 13.7 | 257.3 | 130.7 | 61,974,552 | 175,266,415 | 472,156 |
| 6 | Andaman and Nicobar\* | 25.5 | 16.1 | 421.2 | 192.7 | 9,023,870 | 19,319,468 | 46,839 |
| 7 | Bangladesh | 25.5 | 15.4 | 421.2 | 171.7 | 73,916,552 | 171,532,878 | 430,607 |
| 8 | Timor Leste\* | 25.5 | 21.3 | 212.6 | 180.8 | 6,423 | 14,369 | 36 |
| 9 | Philipines | 23.8 | 10.4 | 199.0 | 110.3 | 27,886,714 | 90,271,662 | 252,763 |
| 10 | Japan\* | 22.1 | 13.3 | 185.9 | 127.4 | 100,112 | 289,565 | 785 |
| 11 | Thailand | 22.1 | 13.4 | 185.9 | 126.0 | 30,703,280 | 89,541,480 | 243,495 |
| 12 | Cambodia | 20.4 | 9.8 | 173.4 | 107.1 | 5,040,616 | 16,706,995 | 47,066 |
| 13 | Taiwan | 18.7 | 8.0 | 161.5 | 96.4 | 12,994 | 46,890 | 135 |
| 14 | Hong Kong | 17.0 | 5.7 | 150.0 | 80.9 | 46,635 | 194,432 | 576 |
| 15 | China | 15.3 | 5.6 | 139.0 | 81.8 | 1,266,828 | 5,243,015 | 15,518 |
| 16 | Macau | 15.3 | 8.3 | 139.0 | 98.6 | 477 | 1,689 | 5 |
| 17 | Sri Lanka | 15.3 | 7.6 | 151.1 | 43.4 | 989,212 | 7,118,467 | 22,805 |
| 18 | Vietnam | 15.3 | 6.4 | 139.0 | 87.0 | 17,462,792 | 68,489,813 | 200,548 |
| 19 | India | 13.6 | 7.3 | 119.3 | 41.1 | 13,331,113 | 100,688,547 | 324,135 |
| 20 | Pakistan | 8.5 | 5.0 | 46.5 | 17.9 | 961,184 | 15,842,946 | 53,700 |

1. \*Maximum canopy height could not be accurately measured due to misclassification of mangrove extent.
2. **Supplementary Table 5 | Americas’ mangrove canopy height, aboveground biomass (AGB),**
3. **and carbon estimates based on region-specific allometric equations.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Country** | **Max height (m)** | **Mean height (m)** | **Max AGB**  **(Mg ha-1)** | **Mean AGB**  **(Mg ha-1)** | **Total AGB (Mg)** | **Total carbon (Mg)** | **Total area (ha)** |
| 1 | Colombia | 54.3 | 24.0 | 413.3 | 129.5 | 26,648,548 | 75,973,344 | 205,179 |
| 2 | Venezuela | 52.6 | 30.7 | 392.8 | 184.0 | 45,505,364 | 100,551,457 | 247,252 |
| 3 | Panama | 50.9 | 27.7 | 372.6 | 155.6 | 23,676,218 | 58,979,743 | 152,189 |
| 4 | French Guyana | 49.2 | 23.2 | 352.9 | 129.2 | 10,290,431 | 29,453,310 | 79,640 |
| 5 | Costa Rica | 45.8 | 23.4 | 314.7 | 116.4 | 4,512,007 | 13,998,836 | 38,752 |
| 6 | Guyana | 42.4 | 24.5 | 278.2 | 127.8 | 2,806,631 | 8,105,363 | 21,976 |
| 7 | Brazil | 40.7 | 19.9 | 260.5 | 92.5 | 97,833,808 | 363,245,344 | 1,051,244 |
| 8 | Ecuador | 40.7 | 19.4 | 260.5 | 88.2 | 11,611,429 | 45,065,625 | 131,671 |
| 9 | Guatemala | 40.7 | 24.2 | 260.5 | 120.2 | 4,142,346 | 12,548,011 | 34,503 |
| 10 | Suriname | 40.7 | 17.3 | 260.5 | 80.7 | 6,937,571 | 29,000,268 | 86,001 |
| 11 | El Salvador | 39.0 | 18.0 | 243.3 | 75.9 | 2,550,341 | 11,216,253 | 33,578 |
| 12 | Saint Lucia | 32.2 | 17.7 | 179.1 | 71.6 | 9,892 | 45,725 | 138 |
| 13 | Trinidad and Tobago | 32.2 | 19.5 | 179.1 | 84.3 | 532,507 | 2,144,539 | 6,313 |
| 14 | Honduras | 30.5 | 16.9 | 164.2 | 68.0 | 4,519,796 | 21,857,392 | 66,502 |
| 15 | US Virgin Islands | 30.5 | 13.6 | 164.2 | 47.1 | 8,510 | 56,878 | 181 |
| 16 | Nicaragua | 28.8 | 14.7 | 149.9 | 55.1 | 4,017,509 | 23,354,504 | 72,985 |
| 17 | Barbados | 27.2 | 15.6 | 136.0 | 58.6 | 2,094 | 11,514 | 36 |
| 18 | Dominican Republic | 27.2 | 12.9 | 136.0 | 45.3 | 801,214 | 5,543,970 | 17,687 |
| 19 | Martinique | 27.2 | 14.9 | 136.0 | 54.6 | 58,613 | 343,171 | 1,073 |
| 20 | Mexico | 27.2 | 11.1 | 136.0 | 37.9 | 26,388,806 | 212,888,568 | 689,596 |
| 21 | Anguilla\* | 25.5 | 8.3 | 122.6 | 29.4 | 56 | 574 | 2 |
| 22 | Grenada | 25.5 | 16.1 | 122.6 | 61.1 | 12,704 | 67,394 | 208 |
| 23 | Jamaica | 25.5 | 10.6 | 122.6 | 35.6 | 325,390 | 2,806,067 | 9,143 |
| 24 | Saint Vincent and the | 23.8 | 11.7 | 109.8 | 40.7 | 1,642 | 12,536 | 40 |
| Grenadines\* | |  |  |  |  |  |  |  |
| 25 Belize | | 22.1 | 8.8 | 97.5 | 26.0 | 1,447,931 | 16,717,298 | 55,634 |
| 26 Cuba | | 22.1 | 9.9 | 97.5 | 30.2 | 12,797,064 | 128,397,896 | 423,316 |
| 27 Peru | | 22.1 | 12.1 | 97.5 | 40.1 | 162,545 | 1,256,800 | 4,055 |
| 28 Saint Kitts and Nevis | | 22.1 | 9.9 | 97.5 | 31.6 | 1,637 | 15,732 | 52 |
| 29 United States (continental) | | 22.1 | 10.6 | 97.5 | 33.3 | 7,666,705 | 70,281,607 | 230,140 |
| 30 Guadeloupe | | 20.4 | 11.0 | 85.7 | 34.1 | 101,593 | 911,443 | 2,979 |
| 31 Cayman Islands | | 18.7 | 11.2 | 74.6 | 34.3 | 259,153 | 2,309,178 | 7,544 |
| 32 Aruba | | 17.0 | 7.2 | 64.0 | 20.2 | 1,956 | 28,741 | 97 |
| 33 British Virgin Islands | | 17.0 | 5.8 | 64.0 | 14.2 | 1,090 | 22,465 | 77 |
| 34 Puerto Rico | | 17.0 | 8.2 | 64.0 | 21.8 | 170,687 | 2,333,429 | 7,840 |
| 35 Antigua and Barbuda | | 15.3 | 9.1 | 54.0 | 25.2 | 22,607 | 269,102 | 897 |
| 36 Bahamas | | 13.6 | 5.8 | 44.7 | 13.3 | 1,016,952 | 22,295,189 | 76,367 |
| 37 Haiti | | 13.6 | 7.5 | 44.7 | 18.0 | 261,748 | 4,280,545 | 14,504 |
| 38 Turks and Caicos Islands | | 10.2 | 6.9 | 28.2 | 15.4 | 262,418 | 4,992,163 | 17,017 |

1. \*Maximum canopy height could not be accurately measured due to misclassification of mangrove extent.
2. **Supplementary Table 6 | Middle East’s mangrove canopy height, aboveground biomass**
3. **(AGB), and carbon estimates based on region-specific allometric equations.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Country** | **Max height (m)** | **Mean height (m)** | **Max AGB**  **(Mg ha-1)** | **Mean AGB**  **(Mg ha-1)** | **Total AGB (Mg)** | **Total carbon (Mg)** | **Total area (ha)** |
| 1 Oman | 17.0 | 6.1 | 186.7 | 33.7 | 7,825 | 70,433 | 230 |
| 2 Iran | 11.9 | 5.5 | 91.3 | 24.4 | 300,787 | 3,692,116 | 12,332 |
| 3 Saudi Arabia | 11.9 | 3.9 | 91.3 | 16.2 | 109,564 | 1,941,001 | 6,599 |
| 4 Yemen | 11.9 | 7.4 | 91.3 | 35.2 | 36,737 | 319,725 | 1,043 |
| 5 Qatar | 10.2 | 4.7 | 67.0 | 18.0 | 6,892 | 112,853 | 382 |
| 6 United Arab Emirates | 10.2 | 3.7 | 67.0 | 11.9 | 140,746 | 3,435,388 | 11,805 |
| 7 Bahrain | 6.8 | 2.0 | 29.7 | 4.5 | 328 | 20,902 | 73 |
| 185 |  | | | | | | | |
| 186 |
| 187 |
| 188 |
| 189 |
| 190 |
| 191 |
| 192 |
| 193 |
| 194 |
| 195 |
| 196 |
| 197 |
| 198 |
| 199 |
| 200 |
| 201 |
| 202 |
| 203 |
| 204 |
| 205 |
| 206 |
| 207 |
| 208 |
| 209 |
| 210 |
| 211 |
| 212 |
| 213 |
| 214 |
| 215 |
| 216 |
| 217 |
| 218 |

1. **Supplementary Table 7 | Results from the multivariate ordinary least squares regression**
2. **between the SRTM Hmax and annual precipitation, temperature and tropical cyclone landfall**
3. **frequency at every 1-degree latitude.** Sample size n = 61; adjusted R2 = 0.74, VIF: variance
4. inflation factor.

Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficient** | **p- value** | **standard error** | **95% Confidence**  **Interval** | **VIF**  **scores** |
| Annual Precipitation (mm) 0.0068 | <0.001 | 0.002 | 0.004 to 0.010 | 1.97349 |
| Mean Temperature (°C) 0.2424 | <0.001 | 0.039 | 0.164 to 0.321 | 1.87399 |
| Tropical Cyclone Landfall -0.001 | <0.05 | 0.000 | -0.002 to 0 | 1.41523 |

224

1. **Supplementary Table 8** | **Aboveground biomass calibration models**. Where Hba = 1.0754 **×**
2. HSRTM, Hmax = 1.697 **×** HSRTM (with ICESat RH100), HCHM = 2.7191 **×** H 0.676.

SRTM

**Allometric model *R2* RMSE (Mg ha )**

**–1**

**Region Covered by**

**Allometry name Model**

AGB = 3.254 **×** H 1.5295 0.55 134.3 Global generic power Global

ba

AGB = 1.066 **×** H 2.1295 0.84 72.0 East Africa generic power Somalia to South Africa

ba

AGB = 1.418 **×** Hba 1.6038 0.71 54.3 Americas generic power North, Central and

South America

AGB = 1.589 **×** Hba 2.0067 0.46 103.4 Middle East Asia generic

power

Djibouti to Bangladesh

AGB = exp(3.9042+0.0858 **×** HCHM) 0.55 148.0 South East Asia generic power2 Myenmar to Hawaii

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| AGB = 2.572 **×** Hmax  1.5191 | 0.70 | 180.0 | Global Hmax power | Global |
| AGB = 0.440 **×** Hmax  2.1578 | 0.85 | 66 | East Africa Hmax power | Somalia to South Africa |

AGB = 0.745 **×** H 1.6228 0.70 65 Americas Hmax power North, Central and

227

228

229

230

231

232

233

234

235

236

237

238

239

240

241

242

243

244

245

246

247

248

249

250

251

252

253

254

255

256

max

South America

1. **Supplementary Table 9 | Comparison of this sudy with published global estimates of**
2. **mangrove aboveveground biomass (AGB), belowground biomass (BGB) and carbon (C).**

259

260

**Study**

(1992)9

**(Pg)**

**Mangrove cover map used**

World Atlas of Mangroves (Spalding et al. 2010)8

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **AGB** | **BGB (Pg)** | **Total biomass**  **(Pg)** | **Soil C**  **(Pg)** | **Total C**  **(Pg)** | **Soil C depth**  **(m)** |
| Hutchison et al. (2014)7 2.83 | 1.11 | - | - | - | - |
| Twilley et al. 2.34 | 1.69 | 4.03 | - | - | - |
| Sanders et al. 1.6 | - | - | 9.6 | 11.2 | 2 |

World Resources (1986) (see ref. 9)

**Year of estimate**

1999-

2003

1986

(2016)10

Sanderman et al. (2018)12

- - - 6.4,

resp. 12.6

- 1,

resp. 2

Giri et al. (2011)11 2000

Giri et al. (2011)11 2000

Hamilton & 13 0.82 0.41 - 2.96 4.19 1 Hamilton and Casey

2012

Friess (2018)

Atwood et al. (2017)15

(2016)14

1.8 - - 2.6 4.4 1 Hamilton and Casey

(2016)14

2012

Jardine & Siikamäki (2014)16

- - -

0.94 1 Giri et al. (2011)

5.00 ± 11

2000

Siikamäki et al. (2012)17

Tang et al.

- - 2.1 4.4 6.5 - Giri et al. (2011)11 2000

World Atlas of

(2018)18 1.908 0.725 2.633 - 1.32 -

Mangroves (Spalding et al. 2010)8

2000

Donato et al. (2011)19

data from various sources

data from various sources

data from various sources

data from various sources

4 to -

20

FAO (2007)20 & Giri

et al. (2011)11

(2016)14

Rovai et al. (2018)21

- - - 2.26 - - Hamilton and Casey

261

262

263

264

265

266

267

268

**This study 1.75** ±

**0.77**

**0.84** ±

**0.377**

**1.72 3.6 5.03 1 Giri et al. (2011)11 2000**

|  |  |
| --- | --- |
| 269 | **References** |
| 270 |  |
| 271 | 1. Wang, X., Chao, Y., Shum, C. K., Yi, Y. & Fok, H. S. Comparison of two methods to assess |
| 272 | ocean tide models. *J. Atmos. Ocean. Technol.* **29**, 1159–1167 (2012). |
| 273 | 2. Aslan, A., Rahman, A. F., Warren, M. W. & Robeson, S. M. Mapping spatial distribution and |
| 274 | biomass of coastal wetland vegetation in Indonesian Papua by combining active and passive |
| 275 | remotely sensed data. *Remote Sens. Environ.* **183**, 65–81 (2016). |
| 276 | 3. Rahman, M. M., Khan, M. N. I., Hoque, A. K. F. & Ahmed, I. Carbon stock in the |
| 277 | Sundarbans mangrove forest: spatial variations in vegetation types and salinity zones. *Wetl.* |
| 278 | *Ecol. Manag.* **23,** 269–283 (2015). |
| 279 | 4. Fatoyinbo, T. E., Simard, M., Washington-Allen, R. A. & Shugart, H. H. Landscape-scale |
| 280 | extent, height, biomass, and carbon estimation of Mozambique’s mangrove, forests with |
| 281 | Landsat ETM+ and Shuttle Radar Topography Mission elevation data. *J. Geophys. Res.* |
| 282 | *Biogeosciences* **113**, 1–13 (2008). |
| 283 | 5. Trettin, C. C., Stringer, C. E. & Zarnoch, S. J. Composition, biomass and structure of |
| 284 | mangroves within the Zambezi River Delta. *Wetl. Ecol. Manag.* **24**, 173–186 (2015). |
| 285 | 6. Simard, M., Rivera-monroy, V. H., Mancera-pineda, J. E., Castañeda-Moya, E. & Twilley, |
| 286 | R. R. A systematic method for 3D mapping of mangrove forests based on Shuttle Radar |
| 287 | Topography Mission elevation data, ICEsat / GLAS waveforms and field data: application to |
| 288 | Ciénaga Grande de Santa Marta, Colombia. *Remote Sens. Environ.* **112**, 2131–2144 (2008). |
| 289 | 7. Hutchison, J., Manica, A., Swetnam, R., Balmford, A. & Spalding, M. Predicting global |
| 290 | patterns in mangrove forest biomass. *Conserv. Lett.* **7**, 233–240 (2014). |
| 291 | 8. Spalding, M., Kainuma, M. & Collins, L. *World Atlas of Mangroves*. Earthscan, London |
| 292 | (2010). |
| 293 | 9. Twilley, R. R., Chen, R.H. & Hargis, T. Carbon sinks in mangroves and their implications to |
| 294 | carbon budget of tropical coastal ecosystems. *Water Air Soil Poll.* **64**, 265 –288 (1992). |
| 295 | 10. Sanders, C. J., et al., Are global mangrove carbon stocks driven by rainfall? *J. Geophys. Res.* |
| 296 | *Biogeosci.* **121**, doi:10.1002/2016JG003510 (2016). |
| 297 | 11. Giri, C. et al. Status and distribution of mangrove forests of the world using earth observation |
| 298 | satellite data. *Glob. Ecol. Biogeogr.* **20**, 154–159 (2011). |
| 299 | 12. Sanderman, J. et al. A global map of mangrove forest soil carbon at 30 m spatial resolution. |
| 300 | *Environ. Res. Lett.* **13**, 055002 (2018). |
| 301 | 13. Hamilton, S. E. & Friess, D. A. Global carbon stocks and potential emissions due to |
| 302 | mangrove deforestation from 2000 to 2012. *Nat. Clim. Chang.* **8**, 240–244 (2018). |
| 303 | 14. Hamilton, S. E. & Casey, D. Creation of a high spatio-temporal resolution global database of |
| 304 | continuous mangrove forest cover for the 21st century (CGMFC-21). *Glob. Ecol. Biogeogr.* |
| 305 | **25**, 729–738 (2016). |
| 306 | 15. Atwood, T. B. et al. Global patterns in mangrove soil carbon stocks and losses. *Nat. Clim.* |
| 307 | *Chang.* **7**, 523–528 (2017). |
| 308 | 16. Jardine, S. L. & Siikamäki, J. V. A global predictive model of carbon in mangrove soils. |
| 309 | *Environ. Res. Lett.* **9**, 104013 (2014). |
| 310 | 17. Siikamaäki, J., Sanchirico, J. N. & Jardine, S. L. Global economic potential for reducing |

311 carbon dioxide emissions from mangrove loss. *Proc. Natl. Acad. Sci.* **109**, 14287–14288

312 (2012).

313 18. Tang, W., Zheng, M., Zhao, X., Shi, J., Yang, J. & Trettin, C. C. Big geospatial data

314 analytics for global mangrove biomass and carbon estimation. *Sustainability* **10**,

315 doi:10.3390/su10020472 (2018).

316 19. Donato, D. C. et al. Mangroves among the most carbon-rich forests in the tropics. *Nat.*

317 *Geosci.* **4**, 293–297 (2011).

318 20. Food and Agriculture Organization of the United Nations (FAO). *The World’s Mangroves*

319 *1980–2005* (FAO Forestry Paper 153. FAO, 2007).

320 21. Rovai, A. S. et al. Global controls on carbon storage in mangrove soils. *Nat. Clim. Change* **8**,

321 534–538 (2018).

322

323

324