

# sPlotOpen – An environmentally-balanced, open-access, global dataset of vegetation plots

*This manuscript is still work in progress*

This manuscript ([permalink](#)) was automatically generated from [fmsabatini/sPlotOpen Manuscript@47e4be1](#) on April 14, 2021.

## Authors

✉ Francesco Maria Sabatini<sup>1,2,†</sup>, Jonathan Lenoir<sup>3,†</sup>, Tarek Hattab<sup>4</sup>, Elise Aimee Arnst<sup>5</sup>, Milan Chytrý<sup>6</sup>, Jürgen Dengler<sup>1,7,8</sup>, Patrice De Ruffray<sup>9</sup>, Stephan M. Hennekens<sup>10</sup>, Ute Jandt<sup>1,2</sup>, Florian Jansen<sup>11</sup>, Borja Jiménez-Alfaro<sup>12</sup>, Jens Kattge<sup>13</sup>, Aurora Levesley<sup>14</sup>, Valério D. Pillar<sup>15</sup>, Oliver Purschke<sup>16</sup>, Brody Sandel<sup>17</sup>, Fahmida Sultana<sup>18</sup>, Tsipe Aavik<sup>19</sup>, Svetlana Ačić<sup>20</sup>, Alicia T.R. Acosta<sup>21</sup>, Emiliano Agrillo<sup>22</sup>, Miguel Alvarez<sup>23</sup>, Iva Apostolova<sup>24</sup>, Mohammed A.S. Arfin Khan<sup>25</sup>, Luzmila Arroyo<sup>26</sup>, Fabio Attorre<sup>27</sup>, Isabelle Aubin<sup>28</sup>, Arindam Banerjee<sup>29</sup>, Marijn Bauters<sup>30,31</sup>, Yves Bergeron<sup>32</sup>, Erwin Bergmeier<sup>33</sup>, Idoia Biurrun<sup>34</sup>, Anne D. Bjorkman<sup>35,36</sup>, Gianmaria Bonari<sup>37</sup>, Viktoria Bondareva<sup>38</sup>, Jörg Brunet<sup>39</sup>, Andraž Čarni<sup>40,41</sup>, Laura Casella<sup>42</sup>, Luis Cayuela<sup>43</sup>, Tomáš Černý<sup>44</sup>, Victor Chepinoga<sup>45</sup>, János Csiky<sup>46</sup>, Renata Čušterevska<sup>47</sup>, Els De Bie<sup>48</sup>, André Luis de Gasper<sup>49</sup>, Michele De Sanctis<sup>27</sup>, Panayotis Dimopoulos<sup>50</sup>, Jiri Dolezal<sup>51</sup>, Tetiana Dziuba<sup>52</sup>, Mohamed Abd El-Rouf Mousa El-Sheikh<sup>53,54</sup>, Brian Enquist<sup>55</sup>, Jörg Ewald<sup>56</sup>, Farideh Fazayeli<sup>57,58</sup>, Richard Field<sup>59</sup>, Manfred Finckh<sup>60</sup>, Sophie Gachet<sup>61</sup>, Antonio Galán-de-Mera<sup>62,63,64</sup>, Emmanuel Garbolino<sup>65</sup>, Hamid Gholizadeh<sup>66</sup>, Melisa Giorgis<sup>67</sup>, Valentin Golub<sup>68</sup>, Inger Greve Alsos<sup>69</sup>, John-Arvid Grytnes<sup>70</sup>, Gregory Richard Guerin<sup>71</sup>, Alvaro G. Gutiérrez<sup>72</sup>, Sylvia Haider<sup>1,2</sup>, Mohamed Z. Hatim<sup>73,74</sup>, Bruno Hérault<sup>75,76,77</sup>, Guillermo Hinojos Mendoza<sup>78</sup>, Norbert Hölzel<sup>79</sup>, Jürgen Homeier<sup>80</sup>, Wannes Hubau<sup>81,82</sup>, Adrian Indreica<sup>83</sup>, John A.M. Janssen<sup>84</sup>, Birgit Jedrzejek<sup>79</sup>, Anke Jentsch<sup>85</sup>, Norbert Jürgens<sup>60</sup>, Zygmunt Kački<sup>86</sup>, Jutta Kapfer<sup>87</sup>, Dirk Nikolaus Karger<sup>88</sup>, Ali Kavgaci<sup>89</sup>, Elizabeth Kearsley<sup>90</sup>, Michael Kessler<sup>91</sup>, Larisa Khanina<sup>92</sup>, Timothy Killeen<sup>93</sup>, Andrey Korolyuk<sup>94</sup>, Holger Kreft<sup>95</sup>, Hjalmar S. Kühl<sup>1,96</sup>, Anna Kuzemko<sup>97</sup>, Flavia Landucci<sup>6</sup>, Attila Lengyel<sup>98</sup>, Frederic Lens<sup>99,100</sup>, Débora Vanessa Lingner<sup>101</sup>, Hongyan Liu<sup>102</sup>, Tatiana Lysenko<sup>103,104,105</sup>, Miguel D. Mahecha<sup>1,106</sup>, Corrado Marcenò<sup>6,34</sup>, Vasiliy Martynenko<sup>107</sup>, Jesper Erenskjold Moeslund<sup>108</sup>, Abel Monteagudo Mendoza<sup>109,110</sup>, Ladislav Mucina<sup>111,112</sup>, Jonas V. Müller<sup>113</sup>, Jérôme Munzinger<sup>114</sup>, Alireza Naqinezhad<sup>115</sup>, Jalil Noroozi<sup>116</sup>, Arkadiusz Nowak<sup>117,118</sup>, Viktor Onyshchenko<sup>119</sup>, Gerhard E. Overbeck<sup>120</sup>, Meelis Pärtel<sup>121</sup>, Aníbal Pauchard<sup>122,123</sup>, Robert K. Peet<sup>124</sup>, Josep Peñuelas<sup>125,126</sup>, Aaron Pérez-Haase<sup>127,128</sup>, Tomáš Peterka<sup>6</sup>, Petr Petřík<sup>129</sup>, Gwendolyn Peyre<sup>130</sup>, Oliver L. Phillips<sup>14</sup>, Vadim Prokhorov<sup>131</sup>, Valerijus Rašomavičius<sup>132</sup>, Rasmus Revermann<sup>133,134</sup>, Gonzalo Rivas-Torres<sup>135</sup>, John S. Rodwell<sup>136</sup>, Eszter Ruprecht<sup>137</sup>, Solvita Rūsiņa<sup>138</sup>, Cyrus Samimi<sup>139</sup>, Marco Schmidt<sup>140</sup>, Franziska Schrodtt<sup>59</sup>, Hanhuai Shan<sup>141</sup>, Pavel Shirokikh<sup>107</sup>, Jozef Šibík<sup>142</sup>, Urban Šilc<sup>143</sup>, Petr Sklenář<sup>144</sup>, Željko Škvorc<sup>145</sup>, Ben Sparrow<sup>146</sup>, Marta Gaia Sperandii<sup>21,147</sup>, Zvezdana Stančić<sup>148</sup>, Jens-Christian Svenning<sup>149</sup>, Zhiyao Tang<sup>102</sup>, Cindy Q. Tang<sup>150</sup>, Ioannis Tsiripidis<sup>151</sup>, Kim André Vanselow<sup>152</sup>, Rodolfo Vásquez Martínez<sup>109</sup>, Kiril Vassilev<sup>24</sup>, Eduardo Vélez-Martin<sup>153</sup>, Roberto Venanzoni<sup>154</sup>, Alexander Christian Vibrans<sup>101</sup>, Cyrille Violle<sup>155</sup>, Risto Virtanen<sup>1,156,157</sup>, Henrik von Wehrden<sup>158</sup>, Viktoria Wagner<sup>159</sup>, Donald A. Walker<sup>160</sup>, Donald M. Waller<sup>161</sup>, Hua-Feng Wang<sup>162</sup>, Karsten Wesche<sup>1,163,164</sup>, Timothy J.S. Whitfeld<sup>165</sup>, Wolfgang Willner<sup>116</sup>, Susan K. Wiser<sup>5</sup>, Thomas Wohlgemuth<sup>166</sup>, Sergey Yamalov<sup>167</sup>, Martin Zobel<sup>168</sup>, Helge Bruelheide<sup>1,2</sup>

✉ — To whom correspondence should be addressed: francesco.sabatini@botanik.uni-halle.de

† — These authors contributed equally to this work

2. Martin-Luther University Halle-Wittenberg, Institute of Biology, Am Kirchtor 1, 06108, Halle, Germany
3. Université de Picardie Jules Verne, Unité de Recherche "Ecologie et Dynamique des Systèmes Anthropisés" (EDYSAN), UMR 7058 CNRS, 1 Rue des Louvels, 80000, Amiens, France
4. MARBEC, Univ Montpellier, CNRS, IFREMER and IRD, Sète, France
5. Manaaki Whenua - Landcare Research, PO Box 69040, 7640, Lincoln, New Zealand
6. Masaryk University, Department of Botany and Zoology, Kotlářská 2, 611 37, Brno, Czech Republic
7. Zurich University of Applied Sciences (ZHAW), Vegetation Ecology Group, Institute of Natural Resource Sciences (IUNR), Grüentalstr. 14, 8820, Wädenswil, Switzerland
8. University of Bayreuth, Plant Ecology, Bayreuth Center of Ecology and Environmental Research (BayCEER), Universitätsstr. 30, 95447, Bayreuth, Germany
9. Université de Strasbourg, Institut de biologie moléculaire des plantes-CNRS, 12, rue du Général-Zimmer, F-67084, Strasbourg, France
10. Wageningen Environmental Research, P.O.Box 47, 6700 AA, Wageningen, Netherlands
11. University of Rostock, Faculty of Agricultural and Environmental Sciences, Justus-von-Liebig-Weg 6, 18059, Rostock, Germany
12. University of Oviedo, Research Unit of Biodiversity (CSIC/UO/PA), C. Gonzalo Gutiérrez Quirós s/n, 33600, Mieres, Spain
13. Max Planck Institute for Biogeochemistry, Hans Knöll Str. 10, 07745, Jena, Germany
14. University of Leeds, School of Geography, Woodhouse Lane, LS2 9JT, Leeds, United Kingdom
15. Universidade Federal do Rio Grande do Sul, Department of Ecology, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, RS, Brazil
16. Medical School of the Martin-Luther University Halle-Wittenberg, Institute for Medical Epidemiology, Biometrics and Informatics (IMEBI), Interdisciplinary Center for Health Sciences, Magdeburger Straße 8, 06112, Halle/Saale, Germany
17. Santa Clara University, Department of Biology, 500 El Camino Real, 95053, Santa Clara CA, United States
18. Shahjalal University of Science & Technology, Forestry & Environmental Science, 3114, Sylhet, Bangladesh
19. University of Tartu, Department of Ecology and Earth Sciences, Department of Botany, Lai 40, Tartu 51005, Estonia
20. University of Belgrade, Faculty of Agriculture, Department of Botany, Nemanjina 6, 11080, Belgrade-Zemun, Serbia
21. Roma Tre University, Department of Sciences, V.le Marconi 446, 00146, Rome, Italy
22. ISPRA - Italian National Institute for Environmental Protection and Research, Biodiversity Conservation Department, Via Vitaliano Brancati 60, 00144, Rome, Italy
23. University of Bonn, Plant Nutrition, INRES, Karlrobert-Kreiten-Str., 53115, Bonn, Germany
24. Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Department of Plant and Fungal Diversity and Resources, Acad. Georgi Bonchev 23, 1113, Sofia, Bulgaria
25. Shahjalal University of Science & Technology, Forestry & Environmental Science, Akhalia, 3114, Sylhet, Bangladesh
26. Universidad Autónoma Gabriel René Moreno, Dirección de la Carrera de Biología, Santa Cruz de la Sierra, Bolivia
27. Sapienza University of Rome, Department of Environmental Biology, P.le Aldo Moro 5, 00185, Rome, Italy
28. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, 1219 Queen St. East, P6A 2E5, Sault Ste Marie, ON, Canada
29. University of Illinois Urbana Champaign, Department of Computer Science, 201 North Goodwin Avenue MC 258, Urbana, IL 61801, 61801.0, Urbana, USA
30. Ghent University, Department Green chemistry and technology, Isotope Bioscience laboratory (UGent-ISOFYS), Coupure Links 653, 9000, Ghent, Belgium
31. Ghent University, Department Environment, Computational and Applied Vegetation Ecology (UGent-CAVELab), Coupure Links 653, 9000, Ghent, Belgium
32. Université du Québec en Abitibi-Témiscamingue, Forest Research Institute, 445 boul. de l'Université, J9X5E4, Rouyn-Noranda, Canada
33. University of Göttingen, Vegetation Ecology and Phytodiversity, Untere Karspüle 2, 37073, Göttingen, Germany
34. University of the Basque Country UPV/EHU, Plant Biology and Ecology, P.O. Box 644, 48080, Bilbao, Spain
35. University of Gothenburg, Department of Biological and Environmental Sciences, Carl Skottsbergs gata 22B, 41319, Gothenburg, Sweden
36. Gothenburg Global Biodiversity Centre, Carl Skottsbergs gata 22B, 41319, Gothenburg, Sweden
37. Free University of Bozen-Bolzano, Piazza Università, 5, 39100, Bolzano, Italy
38. Institute of Ecology of the Volga River Basin, Laboratory of Phytodiversity Problem and of Phytocoenology, Komzina, 10, 445003, Toljatty, Russian Federation
39. Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Sundsvägen 3, 230 53 Alnarp, Sweden
40. Research Center of the Slovenian Academy of Sciences and Arts, Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenia
41. University of Nova Gorica, School for viticulture and enology, Vipavska 13, 5000, Nova Gorica, Slovenia
42. ISPRA - Italian National Institute for Environmental Protection and Research, Biodiversity Conservation Department, Via Vitaliano Brancati, 60, 00144, Roma, Italy
43. Universidad Rey Juan Carlos, Department of Biology and Geology, Physics and Inorganic Chemistry, c/ Tulipán s/n, 29833, Móstoles, Spain
44. Czech University of Life Sciences Prague, Department of Forest Ecology, Faculty of Forestry and Wood Sciences, Kamýcká 1176, 165 21, Praha 6 - Suchbát, Czech Republic

45. Central Siberian Botanical Garden SB RAS, Zolotodolinskaya Str. 101, 630090, Novosibirsk, Russian Federation
46. University of Pécs, Department of Ecology, Ifjúság u. 6., 7624, Pécs, Hungary
47. Ss. Cyril and Methodius University, Institute of Biology, Faculty of Natural Sciences and Mathematics, Arhimedova 3, 1000, Skopje, Republic of North Macedonia
48. Research Institute for Nature and Forest (INBO), Biotope Diversity, Havenlaan 88, bus 73, 1000, Brussels, Belgium
49. Universidade Regional de Blumenau, Rua Antonio da Veiga, 140, Blumenau, 89030-903, Brazil
50. University of Patras, Laboratory of Botany, Division of Plant Biology, Department of Biology, University Campus, 26504, Patras, Greece
51. Institute of Botany, Czech Academy of Sciences, Department of Functional Ecology, Dukelska 135, 37901, Trebon, Czech Republic
52. M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Geobotany and ecology, Tereshchenkivska, 1004, Kyiv, Ukraine
53. College of Science, King Saud University, Botany and Microbiology Department, P.O. Box 2455, 11451, Riyadh, Saudi Arabia
54. Damanhour University, Botany Department, Faculty of Science, Damanhour, Egypt
55. University of Arizona, Ecology and Evolutionary Biology, 1041 E. Lowell St., AZ 85721, Tucson, United States
56. Hochschule Weihenstephan-Triesdorf, University of Applied Sciences, Hans-Carl-von-Carlowitz-Platz 3, 85354, Freising, Germany
57. Google LLC, 1600 Amphitheatre Pkwy, 94043.0, Mountain View, USA
58. University of Minnesota - Twin Cities, USA
59. University of Nottingham, School of Geography, University Park, NG7 2RD, Nottingham, United Kingdom
60. University of Hamburg, Biodiversity, Ecology and Evolution of Plants, Institute for Plant Science & Microbiology, Ohnhorststr. 18, 22609, Hamburg, Germany
61. Aix Marseille Univ, Avignon Université, CNRS, IRD, IMBE, Campus St-Jérôme Etoile, 13397, Marseille, France
62. Universidad CEU San Pablo, Laboratorio de Botánica, P.O. Box 67, 28660, Boadilla del Monte, Madrid, Spain
63. Universidad Privada Antonio Guillermo Urrelo, Laboratorio de Botánica, Jr. José Sabogal
64. Estudios Fitogeográficos del Perú, Herbario AQP, Sánchez Cerro 219, Manuel Prado, Paucarpata, Arequipa, Peru
65. Climact Data Science (CDS), Nova Sophia - Regus Nova, 291 rue Albert Caquot, CS 40095, 06902, Sophia Antipolis Cedex, France
66. University of Mazandaran, Department of Plant Biology, Babolsar, Iran
67. Instituto Multidisciplinario de Biología Vegetal (IMBIV-CONICET), Ecología vegetal y fitogeografía, Av. Vélez Sársfield 1611, 5000, Córdoba, Argentina
68. Institute of Ecology of the Volga River Basin, Laboratory of Phytocoenology, Komzina, 10, 445003, Toljatty, Russian Federation
69. The Arctic University Museum of Norway, UiT - The Arctic University of Norway, Tromsø, Norway
70. University of Bergen, Department of Biological Sciences, Postbox 7803, Bergen, Norway
71. University of Adelaide, School of Biological Sciences, North Terrace, 5005, Adelaide, Australia
72. Universidad de Chile, Departamento de Ciencias Ambientales y Recursos Naturales Renovables, Facultad de Ciencias Agronomicas, Santa Rosa 11315, La Pintana, 8820808, Santiago, Chile
73. Wageningen University, Plant Ecology and Nature Conservation Group - Environmental Sciences Department, P.O. Box Postbus 47, Droevendaalsesteeg 3, 6700 AA, Wageningen, Netherlands
74. Tanta University, Botany and Microbiology Department - Faculty of Science, El Geish St., 31527, Tanta, Egypt
75. CIRAD, UPR Forêts et Sociétés, Yamoussoukro, Ivory Coast
76. University of Montpellier, Forêts et Sociétés, CIRAD, Montpellier, France
77. INP-HB, Institut National Polytechnique Félix Houphouët-Boigny, Yamoussoukro, Côte d'Ivoire
78. ASES Ecological and Sustainable Services, Pépinière d'Entreprises l'Espéridou, Parc d'Activités du Vinobre, 555 Chemin des Traverses, Lachapelle-sous-Aubenas, 07200, Aubenas, France
79. University of Münster, Institute of Landscape Ecology, Heisenbergstr. 2, 48149, Münster, Germany
80. University of Goettingen, Plant Ecology and Ecosystems Research, Untere Karspuele 2, 37073, Goettingen, Germany
81. Ghent University, Department Environment, Laboratory of Wood Biology (UGent-WoodLab), Coupure Links 653, 9000, Ghent, Belgium
82. Royal Museum for Central Africa, Service of Wood Biology, Leuvensesteenweg 13, 3080, Tervuren, Belgium
83. Transilvania University of Brasov, Department of Silviculture, Sirul Beethoven 1, 500123, Brasov, Romania
84. Wageningen University and Research, Wageningen Environmental Research (Alterra), P.O.Box 47, 6700 AA, Wageningen, Netherlands
85. University of Bayreuth, Disturbance Ecology, Bayreuth Center of Ecology and Environmental Research, Universitaetsstr. 30, 95447, Bayreuth, Germany
86. University of Wrocław, Botanical Garden, Sienkiewicza 23, 50-335, Wrocław, Poland
87. Norwegian Institute of Bioeconomy Research, Holtvegen, 66, Tromsø, 9016, Norway
88. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Biodiversity and Conservation Biology, Zürcherstrasse 111, 8903, Birmensdorf, Switzerland
89. Karabuk University, Faculty of Forestry, Kilavuzlar Köyü Öte Karsi Üniversite Kampüsü Merkez, 78050, Karabuk, Turkey
90. Ghent University, Department Environment, Computational and Applied Vegetation Ecology (UGent-CAVELab), Coupure Links 653, 9000, Gent, Belgium

91. University of Zurich, Department of Systematic and Evolutionary Botany, Zollikerstrasse 107, 8008, Zurich, Switzerland
92. branch of the M.V. Keldysh Institute of Applied Mathematics of Russian Academy of Sciences, Institute of Mathematical Problems of Biology of RAS, 1 Prof. Vitkevich, 142290.0, Pushchino, Russia
93. Universidad Autonoma Gabriel Rene Moreno, Museo de Historia Natural Noel Kempff Mercado, Santa Cruz de la Sierra, Bolivia
94. Central Siberian Botanical Garden, Siberian Branch, Russian Academy of Sciences, Geosystem Laboratory, Zolotodolinskaya str. 101, 630090, Novosibirsk, Russian Federation
95. University of Göttingen, Department of Biodiversity, Macroecology and Biogeography, Büsgenweg 1, 37077, Göttingen, Germany
96. Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103, Leipzig, Germany
97. M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine, Department of Geobotany and Ecology, 2, Tereshchenkivska str., 01601, Kyiv, Ukraine
98. Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2-4., 2163, Vácrtót, Hungary
99. Naturalis Biodiversity Center, Research Group Functional Traits, Darwinweg 2, 2333 CR, Leiden, The Netherlands
00. Leiden University, Institute of Biology Leiden, Sylviusweg 72, 2333 BE, Leiden, The Netherlands
01. Universidade Regional de Blumenau, Departamento de Engenharia Florestal, Rua São Paulo, 3250, 89030-000, Blumenau, Brazil
02. Peking University, College of Urban and Environmental Sciences, Yiheyuan Rd. 5, 100871, Beijing, China
03. Komarov Botanical Institute RAS, Laboratory of Vegetation Science, Prof. Popov 2, 197376, Saint-Petersburg, Russian Federation
04. Institute of Ecology of the Volga River Basin RAS - Branch of the Samara Scientific Center RAS, Laboratory of Phytodiversity Problems, Komzin str. 10, 445003, Togliatti, Russian Federation
05. Tobolsk complex scientific station of Ural Branch RAS, Group of Ecology of Living Organisms, Academician Yu. Osipov str. 15, 626152, Tobolsk, Russian Federation
06. University of Leipzig, Remote Sensing Centre for Earth System Research, Talstr. 35, 04103, Leipzig, Germany
07. Ufa Federal Scientific Center of the Russian Academy of Sciences, Ufa Institute of Biology, prospekt Oktyabrya, 69, 450054, Ufa, Russian Federation
08. Aarhus University, Department of Bioscience, Grenaaavej 14, 8410, Roende, Denmark
09. Jardín Botánico de Missouri Oxapampa, Bolognesi Mz-E-6, Oxapampa, Pasco, Peru
10. Universidad Nacional de San Antonio Abad del Cusco, Av. de la Cultura 733, Cusco, Peru
11. Murdoch University, Harry Butler Institute, 90 South Street, Building 390, Murdoch 6150, Perth, Australia
12. Stellenbosch University, Dept. of Geography & Environmental Studies, Private Bag X1, Matieland 7602, Stellenbosch, South Africa
13. Royal Botanic Gardens, Kew, Conservation Science, Wakehurst Place, RH17 6TN, Ardingly, West Sussex, United Kingdom
14. AMAP, Université de Montpellier, CIRAD, CNRS, INRAE, IRD, 34000, Montpellier, France
15. University of Mazandaran, Department of Plant Biology, P.O. Box 47416-95447, Mazandaran, Iran
16. University of Vienna, Department of Botany and Biodiversity Research, Rennweg 14, 1030, Vienna, Austria
17. Polish Academy of Sciences, Botanical Garden - Center for Biodiversity Conservation, Prawdziwka 2, 02-950, Warsaw, Poland
18. University of Opole, Institute of Biology, Oleska St. 52, 45-052, Opole, Polska
19. National Academy of Sciences of Ukraine, M.G. Kholodny Institute of Botany, Tereshchenkivska 2, 01601, Kyiv, Ukraine
20. Universidade Federal do Rio Grande do Sul, Department of Botany, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, Brazil
21. University of Tartu, Institute of Ecology and Earth Sciences, Lai 40, 51005, Tartu, Estonia
22. Universidad de Concepción, Laboratorio de Invasiones Biológicas (LIB), Facultad de Ciencias Forestales, Victoria 631, 4030000, Concepción, Chile
23. Institute of Ecology and Biodiversity (IEB), Chile
24. University of North Carolina, Department of Biology, CB3280, South Road, 27599-3280, Chapel Hill, NC, United States
25. CSIC, Global Ecology Unit CSIC-CREAF-UAB, Edifici C, Campus UAB, 08193, Bellaterra, Catalonia, Spain
26. CREAF, Edifici C, 08193, Cerdanyola del Valles, Catalonia, Spain
27. University of Vic-Central University of Catalonia, Department of Biosciences, Carrer de la Laura, 13, 08500, Vic, Barcelona, Spain
28. University of Barcelona, Department of Evolutionary Biology, Ecology and Environmental Sciences, Diagonal 643, 08028, Barcelona, Spain
29. Czech Academy of Sciences, Department of vegetation ecology, Institute of Botany, Zámek 1, 25243, Průhonice, Czech Republic
30. University of the Andes, Department of Civil and Environmental Engineering, Carrera 1 Este No. 19A-40, Edificio Mario Laserna, Piso 6, 111711, Bogota, Colombia
31. Kazan Federal University, Institute of Environmental Sciences, Kremlevskaya 18, 420008, Kazan, Russian Federation
32. Nature Research Centre, Institute of Botany, Zaliuju Ezeru 49, 08406, Vilnius, Lithuania
33. University of Hamburg, Biodiversity, Ecology and Evolution of Plants/Institute for Plant Science & Microbiology, Ohnhorststr. 18, 22609, Hamburg, Germany
34. Namibia University of Science and Technology, Faculty of Natural Resources and Spatial Sciences, Windhoek, Namibia

35. Universidad San Francisco de Quito, COCIBA, Diego de Robles, 170177, Quito, Ecuador
36. 7 Derwent Road, LA1 3ES, Lancaster, United Kingdom
37. Babeş-Bolyai University, Hungarian Department of Biology and Ecology, Faculty of Biology and Geology, Republicii street 42., 400015, Cluj-Napoca, Romania
38. University of Latvia, Faculty of Geography and Earth Sciences, Jelgavas iela 1, LV 1004, Riga, Latvia
39. University of Bayreuth, Climatology, Bayreuth Center of Ecology and Environmental Research (BayCEER), Universitätsstr. 30, 95447, Bayreuth, Germany
40. Stadt Frankfurt am Main - Der Magistrat, Palmengarten, Siesmayerstraße 61, 60323, Frankfurt am Main, Germany
41. Microsoft, One Microsoft Way, 98052.0, Redmond, WA, United States
42. Plant Science and Biodiversity Centre Slovak Academy of Sciences, Institute of Botany, Dubravská cesta 9, 84523, Bratislava, Slovakia
43. Research Centre of Slovenian Academy of Sciences and Arts (ZRC SAZU), Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenia
44. Department of Botany, Charles University, Benatská 2, 12801 Prague, Czech Republic
45. University of Zagreb, Faculty of Forestry and Wood Technology, Svetošimunska 25, 10000, Zagreb, Croatia
46. University of Adelaide, TERN, North Terrace, 5005, Adelaide, Australia
47. CSIC-UV-GV, Centro de Investigaciones sobre Desertificación, Carretera Moncada-Náquera km 4.5, 46113.0, Moncada (Valencia), Spain
48. University of Zagreb, Faculty of Geotechnical Engineering, Hallerova aleja 7, 42000, Varaždin, Croatia
49. Aarhus University, Department of Biology, Ny Munkegade 114, DK-8000, Aarhus C, Denmark
50. Yunnan University, School of Ecology and Environmental Science, Building Shixun, Chenggong Campus, Dongwaihuan South Road, University Town, Chenggong New District, 650504, Kunming, China
51. Aristotle University of Thessaloniki, School of Biology, 54124, Thessaloniki, Greece
52. University of Erlangen-Nuremberg, Department of Geography, Wetterkreuz 15, 91058, Erlangen, Germany
53. ILEX Consultoria Científica, Amelia Telles 184, 90.460-070, Porto Alegre, Brazil
54. University of Perugia, Department of Chemistry, Biology and Biotechnology, Borgo XX giugno 74, 06124, Perugia, Italy
55. Univ Montpellier, CNRS, EPHE, IRD, Univ Paul Valéry Montpellier 3, CEFE, 1919 route de Mende, 34293, Montpellier, France
56. University of Oulu, Ecology and Genetics Research Unit, Biodiversity Unit, Kaitoväylä 5, 90014, Oulu, Finland
57. Helmholtz Center for Environmental Research - UFZ, Department of Physiological Diversity, Permoserstr. 15, 04318, Leipzig, Germany
58. Leuphana University of Lüneburg, Institute of Ecology, Universitätsallee 1, 21335, Lüneburg, Germany
59. University of Alberta, Department of Biological Sciences, Biological Sciences Building, T6G2E9, Edmonton, Canada
60. University of Alaska, Institute of Arctic Biology, P. O. Box 7570000, 99775, Fairbanks, United States
61. University of Wisconsin-Madison, Botany, 430 Lincoln Drive, 53706, Madison, United States
62. Hainan University, Hainan Key Laboratory for Sustainable Utilization of Tropical Bioresources, College of Tropical Crops, 58 Renmin Avenue, Meilan District, 570228, Haikou, China
63. Senckenberg Museum of Natural History Görlitz, Botany Department, PO Box 300 154, 02806, Görlitz, Germany
64. Technische Universität Dresden, International Institute Zittau, Markt 23, 02763, Zittau, Germany
65. University of Minnesota, Bell Museum, 1445 Gortner Avenue, 55108.0, St. Paul, USA
66. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Forest Dynamics, Zürcherstrasse 111, CH-8909, Birmensdorf, Switzerland
67. Ufa Scientific Centre, Russian Academy of Sciences, Laboratory of Wild-Growing Flora, South-Ural Botanical Garden-Institute, Mendeleev str., 195/3, 450080, Ufa, Russian Federation
68. University of Tartu, Institute of Ecology and Earth Sciences, Lai st 40, 51005, Tartu, Estonia

## Short Running Title

---

sPlotOpen: a global vegetation plot database

## Abstract

---

**Motivation:** Assessing biodiversity status and trends in plant communities is critical for understanding, quantifying and predicting the effects of global change on ecosystems. Vegetation plots record the occurrence or abundance of all plant species co-occurring within delimited local areas. This allows species absences to be inferred, an information seldom provided by existing global plant datasets. Although many vegetation plots have been recorded, most are not available to the global research community. A recent initiative, called 'sPlot', compiled the first global vegetation plot database, and continues to grow and curate it. The sPlot database, however, is extremely unbalanced

spatially, and is not open-access. Here, we address both these issues by (a) resampling the vegetation plots using several environmental variables as sampling strata (b) securing permission from data holders of 105 local-to-regional datasets to openly release data. We thus present sPlotOpen, the largest open-access dataset of vegetation plots ever released. sPlotOpen can be used to explore global patterns of diversity at the plant community level, as ground truth data in remote sensing applications, or as a baseline for biodiversity monitoring.

**Main types of variable contained:** Vegetation plots (n = 95,104) recording cover or abundance of naturally occurring vascular plant species within delimited areas. sPlotOpen contains three partially overlapping resampled datasets (~50,000 plots each), to be used as replicates in global analyses. Besides geographic location, date, plot size, biome, elevation, slope, aspect, vegetation type, naturalness, coverage of various vegetation layers and source dataset, plot-level data also include community-weighted means and variances of 18 plant functional traits from the 'TRY' database.

**Spatial location and grain:** Global, 0.01-40,000 m<sup>2</sup>.

**Time period and grain:** 1888-2015, recording dates.

**Major taxa and level of measurement:** 42,677 vascular plant taxa, plot-level records.

**Software format:** Three main matrices (.csv), relationally linked.

## Keywords

---

Biodiversity, Biogeography, Big-data, Database, Functional traits, Macroecology, Vascular plants, Vegetation plots

## Background & Summary

---

Biodiversity is facing a global crisis. As many as 1 million species are currently threatened with extinction, the vast majority due to anthropogenic impacts such as land-use and climate change ([1](#), [2](#)). In addition, the rates of biodiversity homogenization and redistribution are accelerating ([3](#), [4](#); [5](#)). Biological assemblages are becoming progressively more similar to each other globally, as local and endemic species go extinct and are replaced by more widespread and competitive native or alien species ([1](#); [5](#)). Many terrestrial and marine species are also shifting their geographical distribution as a response to climate change ([4](#)). This has profound potential impacts on ecosystems and human health ([6](#); [7](#)).

Plant communities are no exception to this biodiversity crisis ([8](#); [9](#); [5](#)). This is particularly worrying since terrestrial vegetation accounts for 80% (450 Gt C) of the living biomass on Earth ([10](#)). Given the central role of vegetation in ecosystem productivity, structure, stability and functioning ([9](#)), assessing biodiversity status and trends in plant communities is paramount for other kingdoms of life and human societies alike.

Monitoring trends in plant biodiversity requires adequate data across a range of spatiotemporal scales ([11](#), [12](#)). Large independent collections of plant occurrence data do exist at the global or continental extent via the Botanical Information and Ecology Network (BIEN) ([13](#)), the Global Inventory of Floras and Traits (GIFT) ([14](#)) or the Global Biodiversity Information Facility (GBIF) (<https://www.gbif.org/>). However, these databases suffer from one or several of the following limitations: (1) imbalance towards tree species only; (2) lack of data on how individual plant species co-occur and interact locally to form plant communities; or (3) coarse spatial resolutions (e.g., one-degree grid cells), which preclude intersection with high resolution remote sensing data and the assessment of biodiversity trends at the plant community level ([15](#)).

There is a long tradition among botanists and phytosociologists to record the cover or abundance of each plant species that occurs in a vegetation plot (here used as a synonym of 'relevé' or 'quadrat') of a given size (i.e. surface area) at a given time (e.g. [16](#)). Compared to presence-only data, vegetation-plot data present many advantages. As all visible plant species are recorded, plots contain information on which plant species do, and do not co-occur in the same locality at a given moment in time ([17](#)). This is important for testing hypotheses related to biotic interactions among plant species. Vegetation-plot data also provide crucial information on where and when a species was absent, therefore improving predictions from current species distribution models ([18](#)). Being spatially explicit, vegetation plots can be resurveyed through time to assess potential changes in plant species composition relative to a baseline ([19](#); [20](#), [5](#)). As they normally contain information on the relative cover or abundance of each species, vegetation plots are also more appropriate for detecting biodiversity changes than data representing only the occurrence of individual species ([21](#), [22](#)).

Globally, however, vegetation-plot data are very fragmented, as they typically stem from a myriad of local research and survey projects ([23](#)). These are fine-grained data (e.g., 1-10,000 m<sup>2</sup>) normally covering small spatial extents (e.g., 1-1,000 km<sup>2</sup>) ([24](#)). With their disparate sampling protocols, standards and taxonomic resolutions, aggregating and harmonizing vegetation plot data proves extremely challenging ([25](#)). It is not surprising, therefore, that these data are rarely used in global-scale research on the biodiversity of plant communities ([26](#); [27](#); [28](#)).

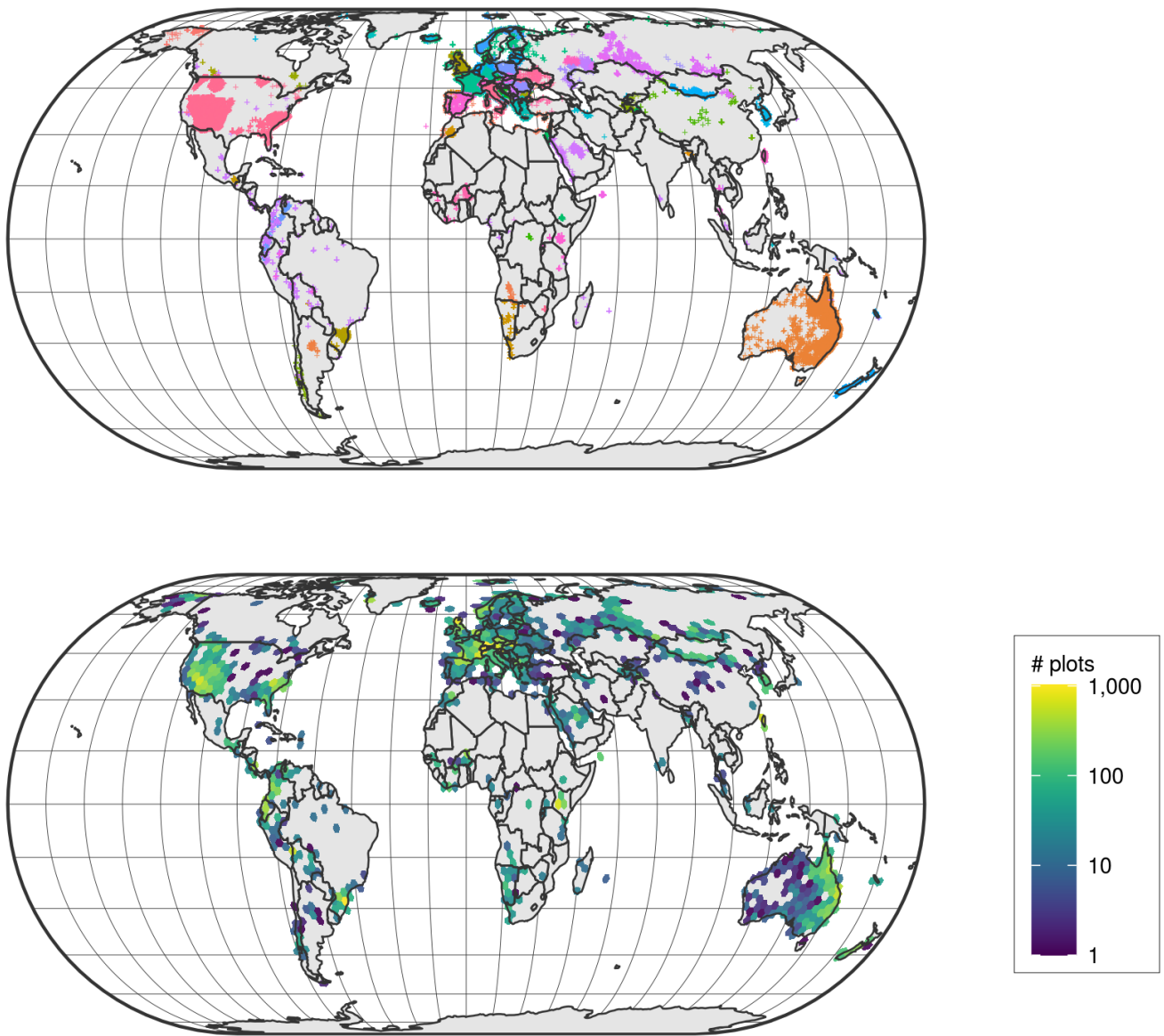
The sPlot initiative tries to close this data gap. It consolidates numerous local to regional vegetation-plot datasets to create a harmonized and comprehensive global database of georeferenced terrestrial plant species assemblages ([23](#)). Established in 2013, sPlot (version 3) currently contains more than 1.9 million vegetation plots, and is fully integrated with the TRY database ([29](#)), from which it derives information on plant functional traits. The sPlot database is increasingly being used to study

continental-to-global scale vegetation patterns ([30](#), [31](#)), such as the relative contribution of regional vs. local factors on the global patterns of fern richness ([32](#)), the mechanisms underlying the spread and abundance of native vs. invasive tree species ([33](#)), and worldwide trait–environment relationships in plant communities ([25](#)).

Yet, most of these data are not open-access. Here, we secured permission from data holders in the sPlot database to openly release a dataset composed of 95,104 vegetation plots. We selected the plots to release using a replicated environmental stratification, in order to represent the entire environmental space covered by the sPlot database. This maximises the benefits of releasing these data for a wide range of potential uses. The selected vegetation plots stem from 105 databases and span 114 countries (Figure [1](#)). This resampled dataset (sPlotOpen - hereafter) is composed of: (1) plot-level information, including metadata and basic vegetation structure descriptors; (2) the vascular plant species composition of each vegetation plot, including species cover or abundance information when available; and (3) community-level functional information obtained by intersection with the TRY database ([29](#)).

sPlotOpen is specifically designed for global macroecological studies, e.g., the exploration of functional diversity patterns at the plant community scale with continental-to-global extent. We expect, however, that sPlotOpen might likewise prove useful to answer a range of different questions, related for instance to species co-occurrence patterns, the definition of species pools, the link between regional vs. local determinants of species diversity, or the niche overlap between co-occurring species. Yet, data in sPlotOpen should not be considered as representative of the distribution of plant communities worldwide, especially when working at local spatial extents. This should be kept in mind for applications such as species distribution models (SDMs) or joint SDMs, whose results might be affected by the uneven geographical distribution of sPlotOpen's data. We refer the reader to the section 'Usage notes' for additional guidance on critical issues related, for instance, to incompletely sampled vegetation plots, varying plot size, and nested vegetation plots.





**Figure 1:** Top: Global distribution of all vegetation plots contained in sPlotOpen ( $n = 95,104$ ). Each color represents a different source dataset ( $n = 105$  - different datasets might have the same color). Bottom: Spatial distribution of vegetation plot density for the environmentally-balanced dataset selected by the first resampling iteration ( $n = 49,787$ ). Densities are calculated in hexagonal cells with a spatial resolution of approximately  $70,000 \text{ km}^2$ . Map projection is Eckert IV.

# Methods

---

## Vegetation plot data sources

We started from the sPlot database v2.1 (created in October 2016), which contains 1,121,244 unique vegetation plots and 23,586,216 species records. Most of the data in sPlot refers to natural and semi-natural vegetation, while vegetation shaped by intensive and repeated human interference, such as cropland or ruderal communities, is hardly represented. Data originate from 110 different vegetation-plot datasets of regional, national or continental extent, some of which stemming from regional or continental initiatives (see [23](#) for more information). For instance: 48 vegetation-plot datasets derive from the European Vegetation Archive (EVA) ([17](#)); three major African datasets derive from the Tropical African Vegetation Archive (TAVA); and multiple vegetation datasets in the USA and Australia derive from the VegBank ([34](#); [35](#)) and TERN's AEKOS ([36](#)) archives, respectively. Data from other continents (South America, Asia) or countries were contributed as separate standalone datasets. The metadata of each individual vegetation-plot dataset stored in sPlot are managed through the Global Index of Vegetation-Plot Databases [GIVD](#) ([37](#)), using the GIVD code as the unique dataset identifier.

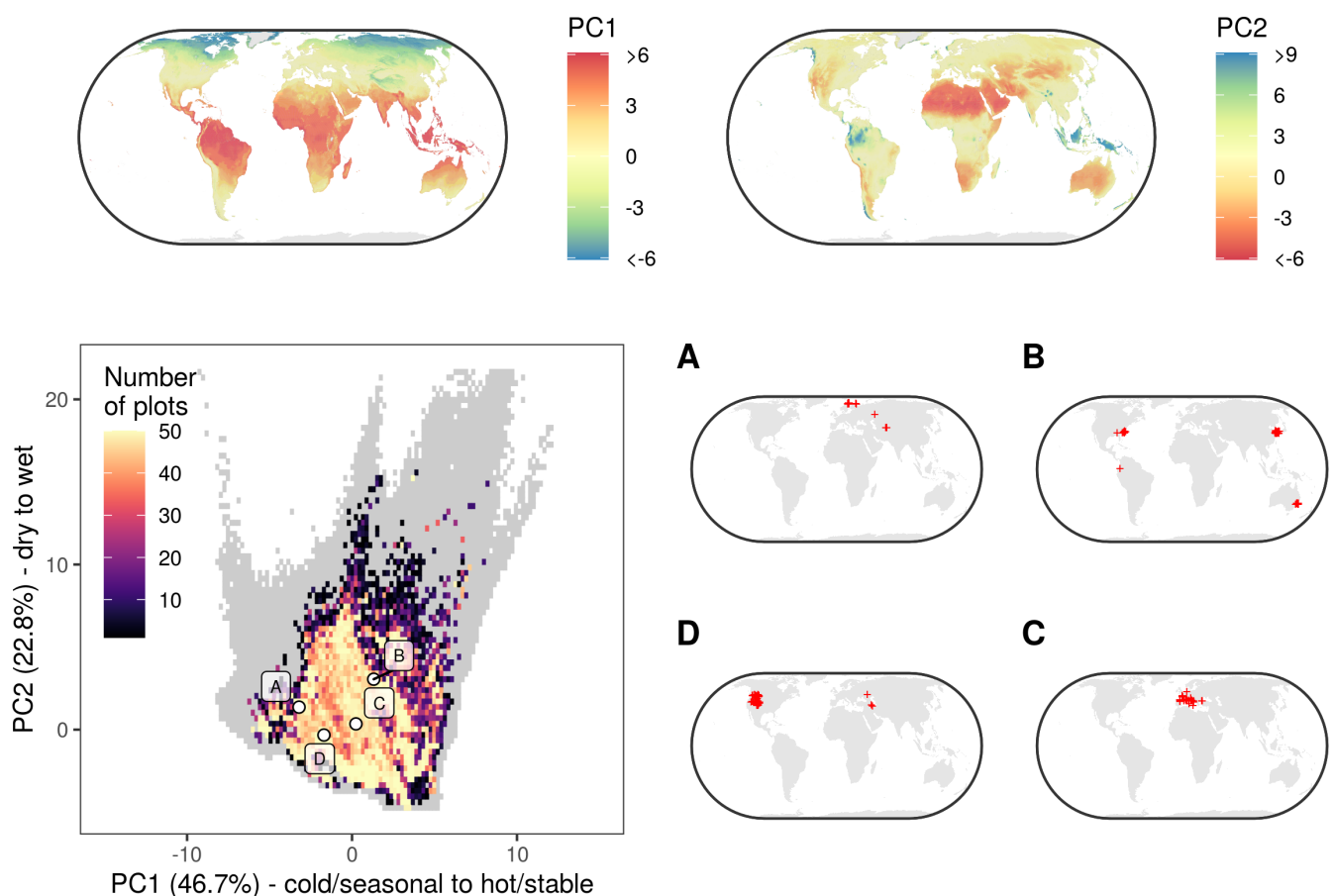
## Resampling method

Data in the sPlot database are unevenly distributed across vegetation types and geographic regions (see [25](#)). Mid-latitude regions in developed countries (mostly Europe, the USA and Australia) are overrepresented in sPlot, while regions in the tropics and subtropics are underrepresented, which is a typical geographical bias in biodiversity data (e.g., [38](#); [4](#)). To reduce this imbalance as much as possible, we performed a stratified resampling approach, using several environmental variables available at global extent as sampling strata.

First, we removed vegetation plots without geographical coordinates or with a location uncertainty higher than 3 km. We also removed vegetation plots identified by the respective data contributors as having been recorded in wetlands or in anthropogenic vegetation types, since these data were available only for few geographic regions, mostly in Europe. This resulted in a total of 799,400 out of the initial set of 1,121,244 vegetation plots.

We then ran a global principal component analysis (PCA) on a matrix of all terrestrial grid cells at a spatial resolution of 2.5 arcmin ( $n = 8,384,404$ ), based on 30 climatic and soil variables. For climate, we used the 19 bioclimatic variables from CHELSA v1.2 ([39](#)), as well as two other bioclimatic variables reflecting the growing-season length (growing degree days above 1 °C - GDD1 - and 5 °C - GDD5), which were derived from CHELSA's monthly average temperatures. Specifically, we summed the number of days of those months with average temperature greater than 1 °C or 5 °C, respectively. In addition, we considered an index of aridity and a layer for potential evapotranspiration from the Consortium of Spatial Information (CGIAR-CSI [40](#)). For soil, we extracted seven variables from the SoilGrids database ([41](#)), namely: (1) soil organic carbon content in the fine earth fraction; (2) cation exchange capacity; (3) pH; as well as the fractions of (4) coarse fragments; (5) sand; (6) silt; and (7) clay. The results of this PCA represents the full environmental space of all terrestrial habitats on Earth, irrespective of whether a grid cell hosted vegetation plots or not (Figure [S1](#)). We then subdivided the PCA ordination space, represented by the first two principal components (PC1–PC2), which accounted for 47% and 23% of the total environmental variation in terrestrial grid cells, into a regular 100 × 100 grid. This PC1-PC2 two-dimensional space was subsequently used to balance our sampling effort across all PC1-PC2 grid cells for which vegetation plots were available. After excluding 42,878 vegetation plots for which no PC1 or PC2 values were available, due to missing data in the bioclimatic or soil variables, we projected the remaining 756,522 vegetation plots onto this PC1-PC2 grid. We finally calculated how many vegetation plots occurred in each PC1-PC2 grid cell (Figure [2](#)).

In total, vegetation plots were available for 1,720 out of the 4,125 PC1-PC2 grid cells covered by the 8,384,404 terrestrial grid cells of the geographical space. We then resampled those PC1-PC2 grid cells ( $n = 858$ ) with more than 50 vegetation plots, which is the median number of plots occurring across occupied grid cells in sPlot. This threshold of 50 vegetation plots represents a compromise between selecting a high number of plots, and keeping the resampled dataset as much balanced as possible across the PC1-PC2 environmental space. To select these 50 vegetation plots we used the heterogeneity-constrained random resampling algorithm from Lengyel et al. (2011) [42]. This approach optimizes the selection of a subset of vegetation plots that encompasses the highest variability in species composition while avoiding peculiar and rare communities, which may represent outliers. As such, our approach maximizes variability over representativeness when resampling vegetation plots. We quantified the variability in plant species composition among the 50 randomly selected vegetation plots by computing the mean and the variance of the Jaccard's dissimilarity index (43) between all possible pairs of these 50 vegetation plots ( $n = 1,225$ ). More precisely, for a given PC1-PC2 grid cell containing more than 50 vegetation plots, we generated 1,000 random selections of 50 vegetation plots and ranked each selection according to the mean (ascending order) and variance (descending order) value of the Jaccard's dissimilarity index. Ranks from both sortings were summed for each random selection, and the selection with the lowest summed rank was considered to provide the most balanced/even representation of vegetation types within the focal grid cell. Where a grid cell contained less than 50 plots, we retained all of them. In this way, we reduced the imbalance towards over-sampled climate types while ensuring that the resampled dataset represents the entire environmental gradient covered by the original sPlot database. We repeated the whole resampling procedure three times to get three different environmentally-balanced, resampled subsets of our vegetation plots. These three resampling iterations can therefore be used as separate replicates, albeit these are not completely independent, as the same plots might have been drawn in different iterations. In addition, those plots located in PC1-PC2 grid cells with less than 50 vegetation plots are completely shared by all three iterations.



**Figure 2:** Distribution of vegetation plots from sPlotOpen in the global environmental space based on a principal component analysis (PCA) using 30 climate and soil variables. Top: Spatial distribution of PCA values across all terrestrial grid cells ( $n = 8,384,404$ , spatial grain = 2.5 arcmin). Bottom Left: Distribution of plots compared to the distribution of all terrestrial 2.5 arc-minute cells (gray background) in the PCA space. Only the plots in the environmentally-balanced dataset selected by the first resampling iteration are shown ( $n = 49,787$ ). The PCA space was divided into a  $100 \times 100$  regular grid. The first and second PCA axis explained 47% and 23% of the total variance. Bottom right: Geographic distribution of the vegetation plots contained in four randomly selected grid cells.

## Permission to release the data as open access

The resampling procedure resulted in 56,486, 56,501 and 56,494 vegetation plots selected during resampling iteration #1, #2 and #3, respectively, for a total 107,238 unique vegetation plots. Since the sPlot database is a consortium of independent datasets whose copyright belongs to the data contributor, we used this preliminary potential selection to ask each dataset's custodian (i.e., either the owner of a dataset or its authorized representative in case of a collective dataset) for permission to release the data of selected vegetation plots as open access. For 12,134 unique vegetation plots, permission could not be granted because, for instance, the data are unpublished, confidential or sensitive. The number of vegetation plots for which the open-access permission was not granted in resampling iteration #1, #2 and #3 were 6,699, 6,690 and 6,705, respectively.

To mitigate the imbalance due to the exclusion of these confidential plots, we created a 'consensus' dataset. We started from resampling iteration #1, and replaced the 6,699 plots not granted as open access, with plots selected in the second and third iteration, for which such permission could be granted ('reserve' plots, hereafter). We imposed the constraint that each candidate vegetation plot in the reserve pool should belong to the same environmental stratum, i.e., the same PC1-PC2 grid cell, of the confidential vegetation plot, even if we acknowledge that this procedure does not maximize the variability in plant species composition of the replacement plots. Even after drawing from reserves, there were 3,150 plots that could not be replaced. These were distributed across 279 PC1-PC2 grid cells (16.2% of occupied cells), each cell having on average 11 irreplaceable plots (min = 1, median = 5, max = 50).

## Trait information

For each vegetation plot for which open access could be granted, we computed the community-weighted mean and variance for eighteen plant functional traits derived from the TRY database v3.0 (29). These traits were selected among those that describe the leaf, wood and seed economics spectra (44; 45), and are known to either affect different key ecosystem processes or respond to macroclimatic drivers, or both (23). The eighteen plant functional traits (all concentrations based on dry weight) were: (1) leaf area [ $\text{mm}^2$ ]; (2) stem specific density [ $\text{g cm}^{-3}$ ]; (3) specific leaf area [ $\text{m}^2\text{kg}^{-1}$ ]; (4) leaf carbon concentration [ $\text{mg g}^{-1}$ ]; (5) leaf nitrogen concentration [ $\text{mg g}^{-1}$ ]; (6) leaf phosphorus concentration [ $\text{mg g}^{-1}$ ]; (7) plant height [m]; (8) seed mass [mg]; (9) seed length [mm]; (10) leaf dry matter content [ $\text{g g}^{-1}$ ]; (11) leaf nitrogen per area [ $\text{g m}^{-2}$ ]; (12) leaf N:P ratio [ $\text{g g}^{-1}$ ]; (13) leaf  $\delta^{15}\text{N}$  [per million]; (14) seed number per reproductive unit; (15) leaf fresh mass [g]; (16) stem conduit density [ $\text{mm}^{-2}$ ]; (17) dispersal unit length [mm]; and (18) conduit element length [ $\mu\text{m}$ ].

Because missing values were particularly widespread in the species-trait matrix, we calculated community-weighted means using the gap-filled version of these traits we received from TRY (29). Gap-filling was performed at the level of individual observations and relies on a hierarchical Bayesian modeling (R package 'BHPMF', 46; 47). This is a Bayesian machine learning approach, with no a priori assumptions, except for the data being missing completely at random. The algorithm "learns" from the data, i.e. if there was a phylogenetic signal in the data, this was used to fill the gaps but where no such signal was apparent, none was introduced. After gap-filling, we transformed to the natural logarithm all gap-filled trait values and averaged each trait by taxon (i.e., at species, or genus level).

The gap-filling approach was run only for species having at least one trait observation ( $n = 21,854$ ). Additional information on the gap-filling procedure is available in [\[23\]](#).

Community-weighted means (CWM) and variances (CWV) were calculated for every plant functional trait  $j$  and every vegetation plot  $k$  as follows ([48](#)):

$$CWM_{j,k} = \sum_i^{n_k} p_{i,k} t_{i,j} \quad (1)$$

$$CWV_{j,k} = \sum_i^{n_k} p_{i,k} (t_{i,j} - CWM_{j,k})^2 \quad (2)$$

where  $n_k$  is the number of species with trait information in vegetation plot  $k$ ,  $p_{i,k}$  is the relative abundance of species  $i$  in vegetation plot  $k$  calculated as the species' fraction in cover or abundance of total cover or abundance, and  $t_{i,j}$  is the mean value of species  $i$  for trait  $j$ .

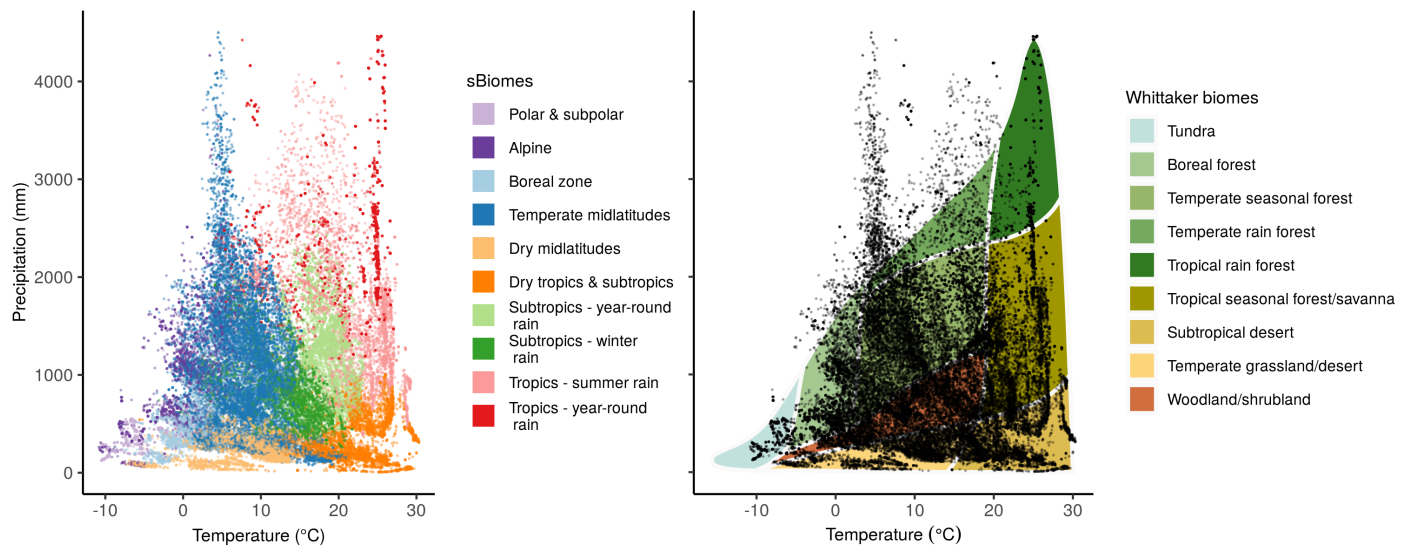
## Data Records

---

sPlotOpen contains 95,104 unique vegetation plots from 105 constitutive datasets (Table 1) and from 114 countries covering all continents except Antarctica (Figure 1). This is the result of pooling together the three environmentally-balanced datasets from resampling iterations #1, #2 and #3 containing 49,787, 49,811 and 49,789 plots, respectively, after excluding the set of plots not granted as open access by data contributors. The number of plots shared across all three resampling iterations is 19,672, while 14,939 plots are shared between two iterations. Replacing confidential plots in resampling iteration #1 with reserves from the other two iterations in the same PC1-PC2 grid cell, resulted in a consensus version containing 53,262 plots. sPlotOpen only contains the species composition of vascular plants; information on the composition of bryophytes and lichens was discarded since it was only available for a minority of plots ( $n = 11,001$  and  $n = 6,801$ , respectively). Information on the size (surface area) of the vegetation survey is available for 67,022 plots, and ranges between 0.03 and 40,000 m<sup>2</sup> (mean = 377 m<sup>2</sup>; median = 100 m<sup>2</sup>). Specifically, sPlotOpen contains 12,894 plots with size smaller than 10 m<sup>2</sup>, 25,742 with size 10-100 m<sup>2</sup>, 24,750 plots with size 100-1,000 m<sup>2</sup> and 3,075 plots with size greater or equal to 1,000 m<sup>2</sup>. Similarly, only for a minority of plots ( $n = 24,167$ ) information on the exact group of plants sampled in the field is available (e.g., complete vegetation, only trees, only trees > 1 m height, and so on). However, as most data were collected using the phytosociological method, we deem safe to assume that, unless otherwise specified, plots contain information on all vascular plants. We retained plots with incomplete vegetation, because they were mostly located in the tropics, i.e., in areas where vegetation plots are particularly scarce otherwise. The average number of vascular plant species per vegetation plot ranges between 1 (i.e. monospecific stands) and 271 species (mean = 20; median = 16).

By capping the number of vegetation plots in overrepresented environmental conditions, the resampling procedure described above strongly reduced the bias in the distribution of vegetation plots within the PC1-PC2 environmental space. Yet, due to the lack or scarcity of data from some geographical regions, like the tropics, there is some remaining imbalance in the spatial distribution of vegetation plots across geographical regions (Figure 1). This is evident when comparing the number of plots across continents or biomes. When considering the first resampling iteration only ( $n = 49,787$ ), Europe is by far the best represented continent, with 15,920 vegetation plots. The least represented continents are Africa and South America, with 3,709 and 5,498 vegetation plots, respectively. Some residual imbalance remains also when considering biomes. With the exception of the 'Temperate mid-latitudes' biome, which includes 14,100 vegetation plots, all other biomes have a number of plots comprised between 1,558 ('Polar and subpolar zone') and 6,245 ('Subtropics with year-round rain') vegetation plots (Figure 3, left). Despite this residual imbalance, all the Whittaker biomes are covered by sPlotOpen (Figure 3, right), and our resampling algorithm has resulted in a much more balanced dataset than many other global datasets that are available, such as GBIF.





**Figure 3:** Distribution of vegetation plots in the first resampling iteration of sPlotOpen ( $n = 49,787$ ) in the two-dimensional climatic space represented by mean annual temperature and mean annual precipitation. Left: plots are color coded based on sBiomes, i.e., sPlot's definition of biomes (23), which derives from Schultz (2005)(49) ecozones, modified to include also the alpine biome from Körner et al. (2017)(50). Right: the same plots superimposed onto Whittaker (1975) biomes (51), as adapted by Rickleff (2008)(52) and plotted using the *R* package *plotbiomes*.

Almost one third of the 95,104 vegetation plots in sPlotOpen belong to forests ( $n = 38,282$ ), one half to non-forest vegetation ( $n = 45,735$ ), with 11.6 % of plots remaining unassigned ( $n = 11,087$ ). When not directly done by data providers, the assignment of plots to forests and non-forests was based on multiple lines of evidence, including the plot-level information on the cover of the tree layer, as well as traits of species composing a plot, such as growth form and height. In short, a plot record was considered as forest if the cover of the tree layer, or alternatively, the sum of the (relative) cover of all tree taxa (scaled by the sum of all cover values, in percentage), was greater than 25%. It was considered a non-forest record if the sum of relative cover of low-stature, non-tree and non-shrub taxa was greater than 90%. For an extensive explanation of this classification scheme, we refer the reader to Bruelheide et al. (2019) [23]. Even if the proportion of forest vs. non-forest vegetation plots is relatively well-balanced, the geographical distribution of vegetation plots belonging to different vegetation types is likely not balanced in the geographical space, as it depends on the idiosyncrasies of the constitutive datasets composing the sPlot database. For instance, the data from New Zealand only include plots collected in non-forest ecosystems, while data from Chile only refer to forests. We urge potential users to carefully read the description of each individual dataset in [GIVD](#) and to contact the custodians of each dataset for further information.

# Database Organization

---

sPlotOpen is organized into three main matrices, relationally linked through the key column *'PlotObservationID'*.

The **'header'** matrix contains plot-level information for the 95,104 vegetation plots, including: metadata (e.g., plot ID, ownership, sampling date, geographical location, positional accuracy); sampling design information (e.g., the total surface area used during the vegetation survey); and a plot-level description of vegetation structure (e.g., vegetation type, percentage cover of each vegetation layer), vegetation type, and naturalness level (i.e., whether a plot belongs to the same formation that would occupy the site without human interference). Plots in Europe are also classified according to the EUNIS habitat classification (column *'ESY'*), based on the habitat classification expert system described in Chytrý et al. (2020) [53]. For each vegetation plot, we further provide information on the dataset it originates from, based on the IDs used in [GIVD](#). We also report four binary fields describing whether a plot belongs to the three resampling iterations (columns *'Resample\_1'*, *'Resample\_2'*, *'Resample\_3'*), or to the first resampling iteration after the inclusion of replacement plots (column *'Resample\_1\_consensus'*). A brief summary of all the 47 variables in the header matrix is provided in Table 2.

The **'DT'** matrix contains data on the species composition of each plot. It is structured in a long format and contains 1,945,384 records from 42,680 vascular plant taxa, mostly resolved at the species level. For each record, we report both the taxon name as originally contributed by the data custodian (column *'Original\_species'*), and the taxon name after taxonomic standardization (column *'Species'*). For details on the taxonomic standardization, please see 'Technical Validation' below. For each species we also provided cover/abundance values. These follow different standards across the datasets constituting the sPlot database. We, therefore, provide both the cover/abundance value as reported in the original data (column *'Original\_abundance'*), together with the abundance scale that was originally used (column *'Abundance\_scale'*). This can take seven values: *'CoverPerc'* = percentage cover; *'pa'* = presence-absence; *'x\_BA'* = basal area (m<sup>2</sup>/ha, only for woody species); *'x\_IC'* = individual count, i.e., number of individuals in plot; *'x\_SC'* = stem count, i.e., number of stems in plot; *'x\_IV'* = importance value index; *'x\_PF'* = presence frequency. The great majority of entries, however, use the percentage cover scale (n= 1,709,000). Finally, for each entry, we calculated a *'Relative\_cover'*, i.e., the cover/abundance of a given taxon divided by the total cover/abundance of all taxa in that vegetation plot.

The **'CWM\_CWV'** matrix contains the community-weighted means and variances calculated for each of the 18 functional traits mentioned above. It also contains three additional columns. The column *'Species\_richness'* shows the number of species recorded in each plot. The columns *'Trait\_coverage\_cover'* and *'Trait\_coverage\_pa'* provide, respectively, the proportion of total cover and the proportion of species in a plot for which functional trait information was available. In total, functional trait information was available for 21,854 species. As functional trait information was based on gap-filled data (see above), each of these 21,854 species had information for all the 18 functional traits. The average proportion of species in each plot for which functional trait information was available is 0.85 (median = 0.95). For 42,012 plots, the coverage was complete, while we do not have functional trait information for any of the species occurring in 482 plots. When considering relative cover, the average trait coverage is 0.87, with 74,151 plots having functional trait information for species cumulatively accounting for more than 80% of relative cover. When considering the number of species, 68,041 plots have functional trait information for 80% or more of the species occurring in that plot.

sPlotOpen contains two additional objects. The **'metadata'** matrix contains plot-level metadata, which provide information on the origin of each individual vegetation plot. This object contains 15 columns,



with information on the dataset of origin (column *'GIVD\_ID'* - [37](#)), author or surveyor names (columns *'Releve\_author'* and *'Releve\_coauthor'*), bibliographic references both at the dataset (column *'DB\_BIBTEXKEY'*) and plot level (*'Plot\_Biblioreference'* and *'BIBTEXKEY'*), when available. Similarly, the column *'Project\_name'* provides information on the project in which a vegetation plot was collected. When available, we also provide information on the numbering of the plots in the publication where they originally appeared (columns *'Nr\_table\_in\_publ'*, *'Nr\_releve\_in\_table'*), or in the dataset where they were initially stored (*'Original\_nr\_in\_database'*). In the case of nested plots ( $n = 1,851$ ), we also provide the original plot and subplot IDs (columns: *'Original\_plotID'*, *'Original\_subplotID'*). The last two columns report plot-level *'Remarks'*, and the unique identifier produced by Turboveg when the vegetation plot was first stored (*'GUID'*).

Finally, the object **'references'**, contains all the bibliographic references formatted according to a BibTex standard. Each reference is tagged with a key corresponding to the fields *'DB\_BIBTEXKEY'* and *'BIBTEXKEY'* in the metadata. We further provide an R function (*'sPlotOpen\_citation'*) to create reference lists, based on a selection of plots and/or datasets.

Except for the 'reference' file (format .bib), all objects/matrices are provided in tab-delimited .txt files. All objects, including the *'sPlotOpen\_citation'* function, are also compiled inside an .RData object.

## Technical Validation

---

The original sPlot database has a nested structure and consists of several individual datasets, each validated and maintained by its respective dataset custodian. In many cases, individual datasets are also collections whose vegetation plots were provided by their respective owners (the person who performed the actual vegetation survey) or by someone who digitized the original data from the scientific published or grey literature. We obviously have no direct control over the individual vegetation plots that we provide here in sPlotOpen. Yet, all these vegetation plots stem from trained professional botanists, or published scientific work, and are accompanied by detailed information on the sampling protocols used, thus ensuring data quality and reliability.

Before integration into the sPlot database, each dataset was further checked for consistency. If the dataset was in a different format, we converted it to a Turboveg 2 dataset ([54](#)). Turboveg is a program specifically designed for the storage, selection and export of vegetation plots (<https://www.synbiosys.alterra.nl/turboveg/>). During this conversion, we checked that all datasets contained the required metadata information, and cross-checked that each plot was located within the geographic scopes of its respective dataset. All individual Turboveg 2 datasets were then integrated into a Turboveg 3 database, and exported to comma-separated files. Finally, we harmonized all the taxonomic names from all datasets, based on the sPlot's taxonomic backbone ([55](#)). This backbone matched all the taxonomic names (without nomenclatural authors) from all datasets in sPlot 2.1 and TRY v3.0 ([29](#)) to their resolved version based on the Taxonomic Name Resolution Service web application (TNRS version 4.0; [56](#)). This allowed us to (1) harmonize all datasets to a common nomenclature, and (2) link the sPlot database to the TRY database ([29](#)). The final backbone only retained matched taxonomic names at the rank of species or higher. Additional detail on the taxonomic resolution is reported in [[23](#)], while a description of the workflow, including R-code, is available in [[55](#)].

## Usage Notes

---

The sPlotOpen database can be downloaded from <https://idata.idiv.de/ddm/Data/ShowData/3474>. Users are urged to cite the original sources when using sPlotOpen in addition to the present paper, particularly when using data contained in BioTIME ([57](#)). For two datasets (AF-00-009, AF-CD-001), the identification of taxa at species level is still in progress. Data on lichens and mosses, where available (e.g., dataset NA-GL-001), can be obtained on request from the respective dataset custodian or sPlot coordinator. As most of the constitutive datasets remain under continuous development, sPlotOpen users are encouraged to get in touch with the custodian(s) of the data they are planning to use (custodian names are reported in <https://www.idiv.de/en/splot>).

The use of sPlotOpen comes with a number of warnings. First, sPlotOpen was resampled in a way that maximizes the compositional variability of vegetation in different environmental conditions. As such, sPlotOpen should not be considered as representative of the distribution of plant communities worldwide. Second, for most regions data was collected opportunistically, and without a randomized sampling design. This might lead to some vegetation types being oversampled in some regions, but undersampled in other regions, which might affect the output of species distribution models, especially at local or regional spatial extents. Third, not all plots were sampled using the same plot size, which should be accounted for when comparing biodiversity indices (e.g., species richness, beta-diversity) across plots or regions. Fourth, not all plots contain complete information on all plant species. A limited number of plots, mostly located in tropical regions, only contain data on woody species. This should be kept in mind when exploring biodiversity patterns. Finally, a small fraction of plots represent nested subsets of larger plots. Depending on the application, this might or might not represent a problem. Nested plots can be identified using the information in the **'metadata'** matrix.

The most appropriate way to deal with these problems depends on the problem being analyzed. Users are therefore invited to carefully consider the limitations above when designing applications relying on sPlotOpen.

The data included in the present paper represent the subset of sPlot for which we were able to secure permission for making these data open. The additional data in sPlot are available under sPlot's Governance and Data Property Rules (<https://www.idiv.de/en/splot>). Using the full sPlot dataset is also recommended if a stratification is desired that is different from the environmental factors used here, for example by geographical region or plot size.

## Code Availability

---

The R code used to produce sPlotOpen from the sPlot 2.1 database is contained in the *sPlotOpen\_code* GitHub repository: [https://github.com/fmsabatini/sPlotOpen\\_Code](https://github.com/fmsabatini/sPlotOpen_Code). A short interactive vignette introducing to the use of sPlotOpen is in [Appendix 1](#). This manuscript was produced using the Manubot workflow ([58](#)). The code for reproducing this manuscript is stored in the *sPlotOpen\_manuscript* GitHub repository: [https://github.com/fmsabatini/sPlotOpen\\_Manuscript](https://github.com/fmsabatini/sPlotOpen_Manuscript).

## Acknowledgements

---

We are grateful to thousands of vegetation scientists who sampled vegetation plots in the field or digitized them into regional, national or international databases. We also appreciate the support of the German Research Foundation for funding sPlot as one of the iDiv (DFG FZT 118, 202548816) research platforms, as well as for funding the position of Francesco Maria Sabatini and the organization of three workshops through the sDiv calls. We acknowledge this support with naming the database “sPlot”, where the “s” refers to the sDiv synthesis workshops.

The study has been supported by the TRY initiative on plant traits (<http://www.try-db.org>). The TRY initiative and database is hosted, developed and maintained by J. Kattge and G. Bönsch (Max Planck Institute for Biogeochemistry, Jena, Germany). TRY is currently supported by DIVERSITAS/Future Earth and the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig. Jens Kattge acknowledges support by the Max Planck Institute for Biogeochemistry (Jena, Germany), Future Earth, the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig and the EU H2020 project BACI, Grant No 640176.

Isabelle Aubin was funded through Natural Sciences and Engineering Research Council of Canada and Ontario Ministry of Natural Resources and Forestry. Yves Bergeron was funded through Natural Sciences and Engineering Research Council of Canada. Idoia Biurrun was funded by the Basque Government (IT936-16). Anne Bjorkman thanks the Herschel Island-Qikiqtaruk Territorial Park management, Catherine Kennedy, Dorothy Cooley, Jill F. Johnstone, Cameron Eckert and Richard Gordon for establishing the ecological monitoring programme. Funding was provided by Herschel Island-Qikiqtaruk Territorial Park. Luis Cayuela was supported by project BIOCON08\_044 funded by Fundación BBVA. Milan Chytrý, Flavia Landucci, Corrado Marcenò and Tomáš Peterka were supported by the Czech Science Foundation (project no. 19-28491X). Brian Enquist thanks the following individuals and institutions for contributing data to sPlot via the SALVIAS database: Mauricio Bonifacino, Saara DeWalt, Timothy Killeen, Susan Letcher, Nigel Pitman, Cam Webb, The Missouri Botanical Garden, RAINFOR and the Amazon Forest Inventory Network. Alvaro G. Gutiérrez was funded by Project FORECOFUN-SSA PIEF-GA-2010-274798 and FONDECYT 1200468. Mohamed Z. Hatim thanks Kamal Shaltout and Joop Schaminée for supervision of the MSc thesis, and Joop Schaminée for support and funding from the Prince Bernard Culture Fund Prize for Nature Conservation. Jürgen Homeier received funding from BMBF (Federal Ministry of Education and Science

of Germany) and the German Research Foundation (DFG Ho3296-2, DFG Ho3296-4). Borja Jiménez-Alfaro was funded by the Spanish Research Agency through grant AEI/10.13039/501100011033. Dirk N. Karger received funding from: The WSL internal grant exCHELSA and ClimEx, the Joint Biodiversa COFUND project 'FeedBaCks' and 'Futureweb', the Swiss Data Science Projects: SPEEDMIND, and COMECO, and the Swiss National Science Foundation (20BD21\_184131). Larisa Khanina was supported by the Ministry of Science and Higher Education of the Russian Federation (project no. AAAA-A19-119012490096-2). Hjalmar Kühl gratefully acknowledges the Pan African team and funding by Max Planck Society and Krekeler Foundation. Attila Lengyel was supported by the National Research, Development and Innovation Office, Hungary (PD-123997). Tatiana Lysenko was funded by Russian Foundation for Basic Research (grant No. 16-04-00747a). Alireza Naqinezhad is supported by a master grant from the University of Mazandaran. Jérôme Munzinger was supported by the French National Research Agency (ANR) with grants INC (ANR-07-BDIV-0008), BIONEOCAL (ANR-07-BDIV-0006) & ULTRABIO (ANR-07-BDIV-0010), by National Geographic Society (Grant 7579-04), and with fundings and authorizations of North and South Provinces of New Caledonia. Arkadiusz Nowak received support from the National Science Centre, Poland, grant no. 2017/25/B/NZ8/00572. Gerhard E. Overbeck acknowledges support from Brazil's National Council of Scientific and Technological Development (CNPq, grant 310022/2015-0). Robert Peet acknowledges the support from the National Center for Ecological Analysis and Synthesis, the North Carolina Ecosystem Enhancement Program, the U.S. Forest Service, and the U.S. National Science Foundation (DBI-9905838, DBI-0213794). Josep Peñuelas acknowledges the financial support from the European Research Council Synergy grant ERC-SyG-2013-610028 IMBALANCE-P. Petr Petřík and Jiri Dolezal acknowledge the support of the long-term research development project No. RVO 67985939 of the Czech Academy of Sciences. Oliver Phillips was funded by an ERC Advanced Grant (291585, "T-FORCES") and a Royal Society-Wolfson Research Merit Award. Valério D. Pillar has been supported by the Brazil's National Council of Scientific and Technological Development (CNPq, grant 307689/2014-0). Solvita Rūsiņa was supported by the University of Latvia grant AAP2016/B041//Zd2016/AZ03 within the "Climate change and sustainable use of natural resources". Franziska Schrodtt was supported by the University of Minnesota Institute on the Environment Discovery Grant, the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig grant (50170649\_#7) and the University of Nottingham Anne McLaren Fellowship. Jozef Šibík was funded by The Slovak Research and Development Agency grant nr. APVV16-0431. Jens Christian Svenning considers this work a contribution to his VILLUM Investigator project "Biodiversity Dynamics in a Changing World" funded by VILLUM FONDEN (grant 16549). Kim André Vanselow would like to thank W. Bernhard Dickoré for the help in the identification of plant species and acknowledges the financial support from the Volkswagen Foundation (AZ I/81 976) and the German Research Foundation (DFG VA 749/1-1, DFG VA 749/4-1). Evan Weiher was funded by NSF DEB-0415383, UWEC-ORSP, and UWEC-BCDT. Work by Karsten Wesche was supported by the German Research Foundation (DFG WE 2601/3-1,3-2, 4-1,4-2) and by the German Ministry for Science and Education (BMBF, CAME 03G0808A). Susan Wiser was funded by the NZ Ministry for Business, Innovation and Employment's Strategic Science Investment Fund.

This paper is dedicated to the memory of Dr. Ching-Feng (Woody) Li.

## Author contributions

---

FMS wrote the first draft of the manuscript, with considerable input from JL and HB. JL and TH wrote the resampling algorithm. FMS set up the GitHub projects, curated the database, and produced the graphs. He also coordinated the sPlot consortium. SMH wrote the Turboveg software, which holds the sPlot database. JK provided the trait data from TRY and FS performed the trait data gap filling. HB secured the funding for sPlot as a strategic project of iDiv. All other authors contributed data and/or helped set up the database and/or helped develop the resampling algorithm. All authors contributed to revising and approved the manuscript.

## Competing interests

---

The authors declare no competing interests.

## Biosketch

---

sPlot is a collaborative initiative to integrate existing local and national vegetation-plot datasets into a global harmonized database. It was initiated in 2013, within the sDiv working group “Plant trait-environment relationships across the world’s biomes”. Since then, it became established as the largest vegetation-plot databases worldwide and coordinates a consortium of 251 individual active members, representing 167 local and national datasets. sPlot’s overarching scientific goal is the exploration of all aspects of global plant community diversity, including taxonomic, functional and phylogenetic diversity, across biomes, vegetation types, taxonomic or functional guilds and scales. Central to sPlot’s mission are the exploration of the relationships between environmental drivers, trait variation, and assembly processes in local plant communities worldwide.

# References

---

1. **Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services**  
IPBES  
*IPBES secretariat* (2019)  
ISBN: [978-3-947851-13-3](#)
2. **Living planet report**  
WWF  
(2018)  
ISBN: [9782940529902](#)
3. **Accelerating homogenization of the global plant-frugivore meta-network**  
Evan C. Fricke, Jens-Christian Svenning  
*Nature* (2020-09-02) <https://doi.org/ghgs3g>  
DOI: [10.1038/s41586-020-2640-y](https://doi.org/10.1038/s41586-020-2640-y) · PMID: [32879498](https://pubmed.ncbi.nlm.nih.gov/32879498/)
4. **Species better track climate warming in the oceans than on land**  
Jonathan Lenoir, Romain Bertrand, Lise Comte, Luana Bourgeaud, Tarek Hattab, Jérôme Murienné, Gaël Grenouillet  
*Nature Ecology & Evolution* (2020-05-25) <https://doi.org/ggx3np>  
DOI: [10.1038/s41559-020-1198-2](https://doi.org/10.1038/s41559-020-1198-2) · PMID: [32451428](https://pubmed.ncbi.nlm.nih.gov/32451428/)
5. **Replacements of small- by large-ranged species scale up to diversity loss in Europe's temperate forest biome**  
Ingmar R. Staude, Donald M. Waller, Markus Bernhardt-Römermann, Anne D. Bjorkman, Jörg Brunet, Pieter De Frenne, Radim Hédli, Ute Jandt, Jonathan Lenoir, František Máliš, ... Lander Baeten  
*Nature Ecology & Evolution* (2020-04-13) <https://doi.org/ggrs73>  
DOI: [10.1038/s41559-020-1176-8](https://doi.org/10.1038/s41559-020-1176-8) · PMID: [32284580](https://pubmed.ncbi.nlm.nih.gov/32284580/)
6. **Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being**  
Gretta T. Pecl, Miguel B. Araújo, Johann D. Bell, Julia Blanchard, Timothy C. Bonebrake, I-Ching Chen, Timothy D. Clark, Robert K. Colwell, Finn Danielsen, Birgitta Evengård, ... Stephen E. Williams  
*Science* (2017-03-31) <https://doi.org/f9xmpm>  
DOI: [10.1126/science.aai9214](https://doi.org/10.1126/science.aai9214) · PMID: [28360268](https://pubmed.ncbi.nlm.nih.gov/28360268/)
7. **Managing consequences of climate-driven species redistribution requires integration of ecology, conservation and social science**  
Timothy C. Bonebrake, Christopher J. Brown, Johann D. Bell, Julia L. Blanchard, Alienor Chauvenet, Curtis Champion, I-Ching Chen, Timothy D. Clark, Robert K. Colwell, Finn Danielsen, ... Gretta T. Pecl  
*Biological Reviews* (2018-02) <https://doi.org/gc2dvc>  
DOI: [10.1111/brv.12344](https://doi.org/10.1111/brv.12344) · PMID: [28568902](https://pubmed.ncbi.nlm.nih.gov/28568902/)
8. **A Significant Upward Shift in Plant Species Optimum Elevation During the 20th Century**  
J. Lenoir, J. C. Gegout, P. A. Marquet, P. de Ruffray, H. Brisse  
*Science* (2008-06-27) <https://doi.org/bnhhj8>  
DOI: [10.1126/science.1156831](https://doi.org/10.1126/science.1156831) · PMID: [18583610](https://pubmed.ncbi.nlm.nih.gov/18583610/)

**9. The functional role of producer diversity in ecosystems**

Bradley J. Cardinale, Kristin L. Matulich, David U. Hooper, Jarrett E. Byrnes, Emmett Duffy, Lars Gamfeldt, Patricia Balvanera, Mary I. O'Connor, Andrew Gonzalez  
*American Journal of Botany* (2011-03) <https://doi.org/fnh8qs>  
DOI: [10.3732/ajb.1000364](https://doi.org/10.3732/ajb.1000364) · PMID: [21613148](https://pubmed.ncbi.nlm.nih.gov/21613148/)

**10. The biomass distribution on Earth**

Yinon M. Bar-On, Rob Phillips, Ron Milo  
*Proceedings of the National Academy of Sciences* (2018-06-19) <https://doi.org/cp29>  
DOI: [10.1073/pnas.1711842115](https://doi.org/10.1073/pnas.1711842115) · PMID: [29784790](https://pubmed.ncbi.nlm.nih.gov/29784790/) · PMCID: [PMC6016768](https://pubmed.ncbi.nlm.nih.gov/PMC6016768/)

**11. Effective Biodiversity Monitoring Needs a Culture of Integration**

Hjalmar S. Kühl, Diana E. Bowler, Lukas Bösch, Helge Bruelheide, Jens Dauber, David. Eichenberg, Nico Eisenhauer, Néstor Fernández, Carlos A. Guerra, Klaus Henle, ... Aletta Bonn  
*One Earth* (2020-10) <https://doi.org/ghgk4w>  
DOI: [10.1016/j.oneear.2020.09.010](https://doi.org/10.1016/j.oneear.2020.09.010)

**12. What we need to know to prevent a mass extinction of plant species**

Stuart L. Pimm  
*PLANTS, PEOPLE, PLANET* (2020-10-28) <https://doi.org/ghhwnp>  
DOI: [10.1002/ppp3.10160](https://doi.org/10.1002/ppp3.10160)

**13. Cyberinfrastructure for an integrated botanical information network to investigate the ecological impacts of global climate change on plant biodiversity**

Brian J Enquist, Rick Condit, Robert K Peet, Mark Schildhauer, Barbara M. Thiers  
*PeerJ* (2018-01-13) <https://doi.org/ghfnxs>  
DOI: [10.7287/peerj.preprints.2615v2](https://doi.org/10.7287/peerj.preprints.2615v2)

**14. GIFT – A Global Inventory of Floras and Traits for macroecology and biogeography**

Patrick Weigelt, Christian König, Holger Kreft  
*Journal of Biogeography* (2019-06-09) <https://doi.org/gf38t6>  
DOI: [10.1111/jbi.13623](https://doi.org/10.1111/jbi.13623)

**15. Distorted Views of Biodiversity: Spatial and Temporal Bias in Species Occurrence Data**

Elizabeth H. Boakes, Philip J. K. McGowan, Richard A. Fuller, Ding Chang-qing, Natalie E. Clark, Kim O'Connor, Georgina M. Mace  
*PLoS Biology* (2010-06-01) <https://doi.org/brfdq6>  
DOI: [10.1371/journal.pbio.1000385](https://doi.org/10.1371/journal.pbio.1000385) · PMID: [20532234](https://pubmed.ncbi.nlm.nih.gov/20532234/) · PMCID: [PMC2879389](https://pubmed.ncbi.nlm.nih.gov/PMC2879389/)

**16. Versuch einer Übersicht über die Wiesentypen der Schweiz**

F. G. Stebler, C. Schröter  
*Landwirt. Jahrb. Schweiz* (1893)

**17. European Vegetation Archive (EVA): an integrated database of European vegetation plots**

Milan Chytrý, Stephan M. Hennekens, Borja Jiménez-Alfaro, Ilona Knollová, Jürgen Dengler, Florian Jansen, Flavia Landucci, Joop H. J. Schaminée, Svetlana Ačić, Emiliano Agrillo, ... Sergey Yamalov  
*Applied Vegetation Science* (2016-01) <https://doi.org/bc7k>  
DOI: [10.1111/avsc.12191](https://doi.org/10.1111/avsc.12191)

**18. Sample selection bias and presence-only distribution models: implications for background and pseudo-absence data**

Steven J. Phillips, Miroslav Dudík, Jane Elith, Catherine H. Graham, Anthony Lehmann, John Leathwick, Simon Ferrier



*Ecological Applications* (2009-01) <https://doi.org/dx4s78>  
DOI: [10.1890/07-2153.1](https://doi.org/10.1890/07-2153.1) · PMID: [19323182](https://pubmed.ncbi.nlm.nih.gov/19323182/)

**19. Global environmental change effects on plant community composition trajectories depend upon management legacies**

Michael P. Perring, Markus Bernhardt-Römermann, Lander Baeten, Gabriele Midolo, Haben Blondeel, Leen Depauw, Dries Landuyt, Sybryn L. Maes, Emiel De Lombaerde, Maria Mercedes Carón, ... Kris Verheyen

*Global Change Biology* (2018-04) <https://doi.org/gc6mjp>  
DOI: [10.1111/gcb.14030](https://doi.org/10.1111/gcb.14030) · PMID: [29271579](https://pubmed.ncbi.nlm.nih.gov/29271579/)

**20. Accelerated increase in plant species richness on mountain summits is linked to warming**

Manuel J. Steinbauer, John-Arvid Grytnes, Gerald Jurasinski, Aino Kulonen, Jonathan Lenoir, Harald Pauli, Christian Rixen, Manuela Winkler, Manfred Bady-Durchhalter, Elena Barni, ... Sonja Wipf

*Nature* (2018-04-04) <https://doi.org/gdfwk3>  
DOI: [10.1038/s41586-018-0005-6](https://doi.org/10.1038/s41586-018-0005-6) · PMID: [29618821](https://pubmed.ncbi.nlm.nih.gov/29618821/)

**21. Exploring large vegetation databases to detect temporal trends in species occurrences**

Ute Jandt, Henrik von Wehrden, Helge Bruelheide

*Journal of Vegetation Science* (2011-12) <https://doi.org/d8b4jv>  
DOI: [10.1111/j.1654-1103.2011.01318.x](https://doi.org/10.1111/j.1654-1103.2011.01318.x)

**22. Phantom species: adjusting estimates of colonization and extinction for pseudo-turnover**

Jared J. Beck, Bret Larget, Donald M. Waller

*Oikos* (2018-11) <https://doi.org/gfn4pn>  
DOI: [10.1111/oik.05114](https://doi.org/10.1111/oik.05114)

**23. sPlot – A new tool for global vegetation analyses**

Helge Bruelheide, Jürgen Dengler, Borja Jiménez-Alfaro, Oliver Purschke, Stephan M. Hennekens, Milan Chytrý, Valério D. Pillar, Florian Jansen, Jens Kattge, Brody Sandel, ... Andrei Zverev

*Journal of Vegetation Science* (2019-04-08) <https://doi.org/gfvhkm>  
DOI: [10.1111/jvs.12710](https://doi.org/10.1111/jvs.12710)

**24. Biodiversity data integration—the significance of data resolution and domain**

Christian König, Patrick Weigelt, Julian Schrader, Amanda Taylor, Jens Kattge, Holger Kreft

*PLOS Biology* (2019-03-18) <https://doi.org/c3xz>  
DOI: [10.1371/journal.pbio.3000183](https://doi.org/10.1371/journal.pbio.3000183) · PMID: [30883539](https://pubmed.ncbi.nlm.nih.gov/30883539/) · PMCID: [PMC6445469](https://pubmed.ncbi.nlm.nih.gov/PMC6445469/)

**25. Global trait–environment relationships of plant communities**

Helge Bruelheide, Jürgen Dengler, Oliver Purschke, Jonathan Lenoir, Borja Jiménez-Alfaro, Stephan M. Hennekens, Zoltán Botta-Dukát, Milan Chytrý, Richard Field, Florian Jansen, ... Ute Jandt

*Nature Ecology & Evolution* (2018-11-19) <https://doi.org/gfj595>  
DOI: [10.1038/s41559-018-0699-8](https://doi.org/10.1038/s41559-018-0699-8) · PMID: [30455437](https://pubmed.ncbi.nlm.nih.gov/30455437/)

**26. Big data for forecasting the impacts of global change on plant communities**

Janet Franklin, Josep M. Serra-Diaz, Alexandra D. Syphard, Helen M. Regan

*Global Ecology and Biogeography* (2017-01) <https://doi.org/f9hdp3>  
DOI: [10.1111/geb.12501](https://doi.org/10.1111/geb.12501)

**27. Achievements and challenges in the integration, reuse and synthesis of vegetation plot data**

Susan K. Wiser



*Journal of Vegetation Science* (2016-09) <https://doi.org/ghfnr5>  
DOI: [10.1111/jvs.12419](https://doi.org/10.1111/jvs.12419)

28. **Managing data locally to answer questions globally: The role of collaborative science in ecology**  
Isabelle Aubin, Françoise Cardou, Laura Boisvert-Marsh, Eric Garnier, Manuella Strukelj, Alison D. Munson  
*Journal of Vegetation Science* (2020-04-03) <https://doi.org/ggtgsm>  
DOI: [10.1111/jvs.12864](https://doi.org/10.1111/jvs.12864)
29. **TRY plant trait database – enhanced coverage and open access**  
Jens Kattge, Gerhard Bönisch, Sandra Díaz, Sandra Lavorel, Iain Colin Prentice, Paul Leadley, Susanne Tautenhahn, Gijsbert D. A. Werner, Tuomas Aakala, Mehdi Abedi, ... Christian Wirth  
*Global Change Biology* (2020) <https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.14904>  
DOI: <https://doi.org/10.1111/gcb.14904>
30. **The relationship between niche breadth and range size of beech ( *Fagus* ) species worldwide**  
Qiong Cai, Erik Welk, Chengjun Ji, Wenjing Fang, Francesco M. Sabatini, Jianxiao Zhu, Jiangling Zhu, Zhiyao Tang, Fabio Attorre, Juan A. Campos, ... Helge Bruelheide  
*Journal of Biogeography* (2021-03-16) <https://doi.org/gjnrnd>  
DOI: [10.1111/jbi.14074](https://doi.org/10.1111/jbi.14074)
31. **Global functional variation in alpine vegetation**  
Riccardo Testolin, Carlos Pérez Carmona, Fabio Attorre, Peter Borchardt, Helge Bruelheide, Jiri Dolezal, Manfred Finckh, Sylvia Haider, Andreas Hemp, Ute Jandt, ... Borja Jiménez-Alfaro  
*Journal of Vegetation Science* (2021-04-06) <https://doi.org/gjnrnf>  
DOI: [10.1111/jvs.13000](https://doi.org/10.1111/jvs.13000)
32. **Global fern and lycophyte richness explained: How regional and local factors shape plot richness**  
Anna Weigand, Stefan Abrahamczyk, Isabelle Aubin, Claudia Bitá-Nicolae, Helge Bruelheide, Cesar I. Carvajal-Hernández, Daniele Ciccuzza, Lucas Erickson Nascimento da Costa, János Csiky, Jürgen Dengler, ... Michael Kessler  
*Journal of Biogeography* (2019-12-30) <https://doi.org/ggf4gr>  
DOI: [10.1111/jbi.13782](https://doi.org/10.1111/jbi.13782)
33. **Similar factors underlie tree abundance in forests in native and alien ranges**  
Masha T. Sande, Helge Bruelheide, Wayne Dawson, Jürgen Dengler, Franz Essl, Richard Field, Sylvia Haider, Mark Kleunen, Holger Kreft, Joern Pagel, ... Tiffany M. Knight  
*Global Ecology and Biogeography* (2019-12) <https://doi.org/ggftj7>  
DOI: [10.1111/geb.13027](https://doi.org/10.1111/geb.13027) · PMID: [32063745](https://pubmed.ncbi.nlm.nih.gov/32063745/) · PMCID: [PMC7006795](https://pubmed.ncbi.nlm.nih.gov/PMC7006795/)
34. **Vegetation-plot database of the Carolina Vegetation Survey**  
Robert K. Peet, Michael T. Lee, M. Forbes Boyle, Thomas R. Wentworth, Michael P. Schafale, Alan S. Weakley  
*Vegetation databases for the 21st century* (2012) <https://doi.org/10.7809/b-e.00081>
35. **VegBank – a permanent, open-access archive for vegetation-plot data**  
Robert K. Peet, M. T. Lee, M. D. Jennings, D. Faber-Langendoen  
*Vegetation databases for the 21st century* (2012) <https://doi.org/10.7809/b-e.00080>
36. **Terrestrial ecosystem research infrastructures: challenges and opportunities**  
Abad Chabbi, Henry W Loescher

(2017)

ISBN: [9780367875763](#)

37. **The Global Index of Vegetation-Plot Databases (GIVD): a new resource for vegetation science**  
Jürgen Dengler, Florian Jansen, Falko Glöckler, Robert K. Peet, Miquel De Cáceres, Milan Chytrý, Jörg Ewald, Jens Oldeland, Gabriela Lopez-Gonzalez, Manfred Finckh, ... Nick Spencer  
*Journal of Vegetation Science* (2011-08) <https://doi.org/ctx2s7>  
DOI: [10.1111/j.1654-1103.2011.01265.x](https://doi.org/10.1111/j.1654-1103.2011.01265.x)
38. **Climate-related range shifts - a global multidimensional synthesis and new research directions**  
J. Lenoir, J.-C. Svenning  
*Ecography* (2015-01) <https://doi.org/f6xz9h>  
DOI: [10.1111/ecog.00967](https://doi.org/10.1111/ecog.00967)
39. **Climatologies at high resolution for the earth's land surface areas**  
Dirk Nikolaus Karger, Olaf Conrad, Jürgen Böhrer, Tobias Kawohl, Holger Kreft, Rodrigo Wilber Soria-Auza, Niklaus E. Zimmermann, H. Peter Linder, Michael Kessler  
*Scientific Data* (2017-09-05) <https://doi.org/gbvksk>  
DOI: [10.1038/sdata.2017.122](https://doi.org/10.1038/sdata.2017.122) · PMID: [28872642](https://pubmed.ncbi.nlm.nih.gov/28872642/) · PMCID: [PMC5584396](https://pubmed.ncbi.nlm.nih.gov/PMC5584396/)
40. **Global High-Resolution Soil-Water Balance**  
Antonio Trabucco, Robert J. Zomer  
*figshare* (2019) [https://figshare.com/articles/Global\\_High-Resolution\\_Soil-Water\\_Balance/7707605/3](https://figshare.com/articles/Global_High-Resolution_Soil-Water_Balance/7707605/3)  
DOI: [10.6084/m9.figshare.7707605.v3](https://doi.org/10.6084/m9.figshare.7707605.v3)
41. **SoilGrids250m: Global gridded soil information based on machine learning**  
Tomislav Hengl, Jorge Mendes de Jesus, Gerard B. M. Heuvelink, Maria Ruiperez Gonzalez, Milan Kilibarda, Aleksandar Blagotić, Wei Shangguan, Marvin N. Wright, Xiaoyuan Geng, Bernhard Bauer-Marschallinger, ... Bas Kempen  
*PLOS ONE* (2017-02-16) <https://doi.org/f9qc5p>  
DOI: [10.1371/journal.pone.0169748](https://doi.org/10.1371/journal.pone.0169748) · PMID: [28207752](https://pubmed.ncbi.nlm.nih.gov/28207752/) · PMCID: [PMC5313206](https://pubmed.ncbi.nlm.nih.gov/PMC5313206/)
42. **Heterogeneity-constrained random resampling of phytosociological databases**  
Attila Lengyel, Milan Chytrý, Lubomír Tichý  
*Journal of Vegetation Science* (2011-02) <https://doi.org/dvjzbx>  
DOI: [10.1111/j.1654-1103.2010.01225.x](https://doi.org/10.1111/j.1654-1103.2010.01225.x)
43. **THE DISTRIBUTION OF THE FLORA IN THE ALPINE ZONE.1**  
Paul Jaccard  
*New Phytologist* (1912-02) <https://doi.org/fvhsjd>  
DOI: [10.1111/j.1469-8137.1912.tb05611.x](https://doi.org/10.1111/j.1469-8137.1912.tb05611.x)
44. **A leaf-height-seed (LHS) plant ecology strategy scheme**  
Mark Westoby  
*Plant and Soil* (1998-02-01) <https://doi.org/10.1023/A:1004327224729>  
DOI: [10.1023/a:1004327224729](https://doi.org/10.1023/a:1004327224729)
45. **The world-wide “fast-slow” plant economics spectrum: a traits manifesto**  
Peter B. Reich  
*Journal of Ecology* (2014-03) <https://doi.org/gfc4z9>  
DOI: [10.1111/1365-2745.12211](https://doi.org/10.1111/1365-2745.12211)

46. **Uncertainty Quantified Matrix Completion Using Bayesian Hierarchical Matrix Factorization**  
Farideh Fazayeli, Arindam Banerjee, Jens Kattge, Franziska Schrod, Peter B. Reich  
*Institute of Electrical and Electronics Engineers (IEEE)* (2014-12) <https://doi.org/ghfnw3>  
DOI: [10.1109/icmla.2014.56](https://doi.org/10.1109/icmla.2014.56)
47. **BHPMF - a hierarchical Bayesian approach to gap-filling and trait prediction for macroecology and functional biogeography**  
Franziska Schrod, Jens Kattge, Hanhuai Shan, Farideh Fazayeli, Julia Joswig, Arindam Banerjee, Markus Reichstein, Gerhard Bönisch, Sandra Díaz, John Dickie, ... Peter B. Reich  
*Global Ecology and Biogeography* (2015-12) <https://doi.org/f76qw8>  
DOI: [10.1111/geb.12335](https://doi.org/10.1111/geb.12335)
48. **Scaling from Traits to Ecosystems**  
Brian J. Enquist, Jon Norberg, Stephen P. Bonser, Cyrille Violle, Colleen T. Webb, Amanda Henderson, Lindsey L. Sloat, Van M. Savage  
*Advances in Ecological Research* (2015) <https://doi.org/ghfnsw>  
DOI: [10.1016/bs.aecr.2015.02.001](https://doi.org/10.1016/bs.aecr.2015.02.001)
49. **The Ecozones of the World**  
Jürgen Schultz  
*Springer Science and Business Media LLC* (2005) <https://doi.org/ft52nn>  
DOI: [10.1007/3-540-28527-x](https://doi.org/10.1007/3-540-28527-x)
50. **A global inventory of mountains for bio-geographical applications**  
Christian Körner, Walter Jetz, Jens Paulsen, Dannah Payne, Katrin Rudmann-Maurer, Eva M. Spehn  
*Alpine Botany* (2016-12-19) <https://doi.org/f93fmr>  
DOI: [10.1007/s00035-016-0182-6](https://doi.org/10.1007/s00035-016-0182-6)
51. **Communities and Ecosystems**  
R. H. Whittaker  
*Macmillan Publishing Co. Inc.* (1975)
52. **The economy of nature**  
Robert E. Ricklefs  
*W.H. Freeman* (2008)  
ISBN: [9780716786979](https://doi.org/9780716786979)
53. **EUNIS Habitat Classification: Expert system, characteristic species combinations and distribution maps of European habitats**  
Milan Chytrý, Lubomír Tichý, Stephan M. Hennekens, Ilona Knollová, John A. M. Janssen, John S. Rodwell, Tomáš Peterka, Corrado Marcenò, Flavia Landucci, Jiří Danihelka, ... Joop H. J. Schaminée  
*Applied Vegetation Science* (2020-08-16) <https://doi.org/ghf4dn>  
DOI: [10.1111/avsc.12519](https://doi.org/10.1111/avsc.12519)
54. **TURBOVEG, a comprehensive data base management system for vegetation data**  
Stephan M. Hennekens, Joop H. J. Schaminée  
*Journal of Vegetation Science* (2001-02-24) <https://doi.org/cgmn6m>  
DOI: [10.2307/3237010](https://doi.org/10.2307/3237010)
55. **Oliverpurschke/Taxonomic\_Backbone: First Release Of The Workflow To Generate The Taxonomic Backbone For Splot V.2.1 And Try V.3.0**  
Oliver Purschke

Zenodo (2017-08-18) <https://doi.org/ghf4ph>  
DOI: [10.5281/zenodo.845445](https://doi.org/10.5281/zenodo.845445)

**56. The taxonomic name resolution service: an online tool for automated standardization of plant names**

Brad Boyle, Nicole Hopkins, Zhenyuan Lu, Juan Antonio Raygoza Garay, Dmitry Mozzherin, Tony Rees, Naim Matasci, Martha L Narro, William H Piel, Sheldon J McKay, ... Brian J Enquist  
*BMC Bioinformatics* (2013-01-16) <https://doi.org/gb8vxz>  
DOI: [10.1186/1471-2105-14-16](https://doi.org/10.1186/1471-2105-14-16) · PMID: [23324024](https://pubmed.ncbi.nlm.nih.gov/23324024/) · PMCID: [PMC3554605](https://pubmed.ncbi.nlm.nih.gov/PMC3554605/)

**57. BioTIME: A database of biodiversity time series for the Anthropocene**

Maria Dornelas, Laura H. Antão, Faye Moyes, Amanda E. Bates, Anne E. Magurran, Dušan Adam, Asem A. Akhmetzhanova, Ward Appeltans, José Manuel Arcos, Haley Arnold, ... Michael L. Zettler  
*Global Ecology and Biogeography* (2018)  
<https://onlinelibrary.wiley.com/doi/abs/10.1111/geb.12729>  
DOI: <https://doi.org/10.1111/geb.12729>

**58. Open collaborative writing with Manubot**

Daniel S. Himmelstein, Vincent Rubinetti, David R. Slochower, Dongbo Hu, Venkat S. Malladi, Casey S. Greene, Anthony Gitter  
*PLOS Computational Biology* (2019-06-24) <https://doi.org/c7np>  
DOI: [10.1371/journal.pcbi.1007128](https://doi.org/10.1371/journal.pcbi.1007128) · PMID: [31233491](https://pubmed.ncbi.nlm.nih.gov/31233491/) · PMCID: [PMC6611653](https://pubmed.ncbi.nlm.nih.gov/PMC6611653/)

**59. ForestPlots.net: a web application and research tool to manage and analyse tropical forest plot data**

Gabriela Lopez-Gonzalez, Simon L. Lewis, Mark Burkitt, Oliver L. Phillips  
*Journal of Vegetation Science* (2011-08) <https://doi.org/dz6zb3>  
DOI: [10.1111/j.1654-1103.2011.01312.x](https://doi.org/10.1111/j.1654-1103.2011.01312.x)

**60. Plot-scale evidence of tundra vegetation change and links to recent summer warming**

Sarah C. Elmendorf, Gregory H. R. Henry, Robert D. Hollister, Robert G. Björk, Noémie Boulanger-Lapointe, Elisabeth J. Cooper, Johannes H. C. Cornelissen, Thomas A. Day, Ellen Dorrepaal, Tatiana G. Elumeeva, ... Sonja Wipf  
*Nature Climate Change* (2012-04-08) <https://doi.org/f223nb>  
DOI: [10.1038/nclimate1465](https://doi.org/10.1038/nclimate1465)

**61. Database of Masaryk University's Vegetation Research in Siberia**

Milan Chytrý  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcp>  
DOI: [10.7809/b-e.00088](https://doi.org/10.7809/b-e.00088)

**62. The West African Vegetation Database**

Marco Schmidt, Thomas Janßen, Stefan Dressler, Karen Hahn, Mipro Hien, Souleymane Konaté, Anne Mette Lykke, Ali Mahamane, Bienvenu Sambou, Brice Sinsin, ... Georg Zizka  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcf>  
DOI: [10.7809/b-e.00065](https://doi.org/10.7809/b-e.00065)

**63. BIOTA Southern Africa Biodiversity Observatories Vegetation Database**

Gerhard Muche, Ute Schmiedel, Norbert Jürgens  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcg>  
DOI: [10.7809/b-e.00066](https://doi.org/10.7809/b-e.00066)

64. **Vegetation Database of the Okavango Basin**  
Rasmus Revermann, Amândio Luis Gomes, Francisco Maiato Gonçalves, Johannes Wallenfang, Torsten Hoche, Norbert Jürgens, Manfred Finckh  
*Phytocoenologia* (2016-06-01) <https://doi.org/ghgt82>  
DOI: [10.1127/phyto/2016/0103](https://doi.org/10.1127/phyto/2016/0103)
65. **Zur Vegetationsökologie der Savannenlandschaften im Sahel Burkina Fasos**  
J. Müller  
*FB Biologie und Informatik, J.W. Goethe-Universität Frankfurt a.M* (2003)
66. **Conventional tree height-diameter relationships significantly overestimate aboveground carbon stocks in the Central Congo Basin**  
Elizabeth Kearsley, Thales de Haulleville, Koen Hufkens, Alidé Kidimbu, Benjamin Toirambe, Geert Baert, Dries Huygens, Yodit Kebede, Pierre Defourny, Jan Bogaert, ... Hans Verbeeck  
*Nature Communications* (2013-08-05) <https://doi.org/ghgt8w>  
DOI: [10.1038/ncomms3269](https://doi.org/10.1038/ncomms3269) · PMID: [23912554](https://pubmed.ncbi.nlm.nih.gov/23912554/)
67. **Responses of plant functional types to environmental gradients in the south-west Ethiopian highlands**  
Desalegn Wana, Carl Beierkuhnlein  
*Journal of Tropical Ecology* (2011-03-10) <https://doi.org/b6mtmx>  
DOI: [10.1017/s0266467410000799](https://doi.org/10.1017/s0266467410000799)
68. **Vegetation Database of Southern Morocco**  
Manfred Finckh  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvccq>  
DOI: [10.7809/b-e.00094](https://doi.org/10.7809/b-e.00094)
69. **{Das Weidepotential im Gutu-Distrikt (Zimbabwe) – Möglichkeiten und Grenzen der Modellierung unter Verwendung von Landsat TM-5**  
C. Samimi  
*Karlsruher Schriften zur Geographie und Geoökologie* (2003)
70. **Classification of Korean forests: patterns along geographic and environmental gradients**  
Tomáš Černý, Martin Kopecký, Petr Petřík, Jong-Suk Song, Miroslav Šrůtek, Milan Valachovič, Jan Altman, Jiří Doležal  
*Applied Vegetation Science* (2015-01) <https://doi.org/ghgt8z>  
DOI: [10.1111/avsc.12124](https://doi.org/10.1111/avsc.12124)
71. **Vegetation of Middle Asia – the project state of art after ten years of survey and future perspectives**  
Arkadiusz Nowak, Marcin Nobis, Sylwia Nowak, Agnieszka Nobis, Grzegorz Swacha, Zygmunt Kącki  
*Phytocoenologia* (2017-12-01) <https://doi.org/gctffg>  
DOI: [10.1127/phyto/2017/0208](https://doi.org/10.1127/phyto/2017/0208)
72. **Vegetation of the woodland-steppe transition at the southeastern edge of the Inner Mongolian Plateau**  
Hongyan Liu, Haiting Cui, Richard Pott, Martin Speier  
*Journal of Vegetation Science* (2000-08) <https://doi.org/cxr92b>  
DOI: [10.2307/3246582](https://doi.org/10.2307/3246582)
73. **Combined effects of livestock grazing and abiotic environment on vegetation and soils of grasslands across Tibet**

Yun Wang, Gwendolyn Heberling, Eugen Görzen, Georg Miehe, Elke Seeber, Karsten Wesche  
*Applied Vegetation Science* (2017-07) <https://doi.org/gbk6v>  
DOI: [10.1111/avsc.12312](https://doi.org/10.1111/avsc.12312)

**74. Community assembly during secondary forest succession in a Chinese subtropical forest**

Helge Bruelheide, Martin Böhnke, Sabine Both, Teng Fang, Thorsten Assmann, Martin Baruffol, Jürgen Bauhus, François Buscot, Xiao-Yong Chen, Bing-Yang Ding, ... Bernhard Schmid  
*Ecological Monographs* (2011-02) <https://doi.org/dmwpsm>  
DOI: [10.1890/09-2172.1](https://doi.org/10.1890/09-2172.1)

**75. Vegetation Database of Sinai in Egypt**

Mohamed Hatim  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcr>  
DOI: [10.7809/b-e.00099](https://doi.org/10.7809/b-e.00099)

**76. Eurosiberian meadows at their southern edge: patterns and phytogeography in the NW Tien Shan**

Viktoria Wagner  
*Journal of Vegetation Science* (2009-03-25) <https://doi.org/ftq2r6>  
DOI: [10.1111/j.1654-1103.2009.01032.x](https://doi.org/10.1111/j.1654-1103.2009.01032.x)

**77. Plant communities of the southern Mongolian Gobi**

Henrik von Wehrden, Karsten Wesche, Georg Miehe  
*Phytocoenologia* (2009-10-21) <https://doi.org/ddvj9h>  
DOI: [10.1127/0340-269x/2009/0039-0331](https://doi.org/10.1127/0340-269x/2009/0039-0331)

**78. Wetland Vegetation Database of Baikal Siberia (WETBS)**

Victor Chepinoga  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcs>  
DOI: [10.7809/b-e.00107](https://doi.org/10.7809/b-e.00107)

**79. Database of Siberian Vegetation (DSV)**

Andrei Zverev, Andrey Korolyuk  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghmxn2>  
DOI: [10.7809/b-e.00108](https://doi.org/10.7809/b-e.00108)

**80. SaudiVeg ecoinformatics: Aims, current status and perspectives**

Mohamed A. El-Sheikh, Jacob Thomas, Ahmed H. Alfarhan, Abdulrahman A. Alatar, Sivadasan Mayandy, Stephan M. Hennekens, Joop H. J. Schaminée, Ladislav Mucina, Abdulla M. Alansari  
*Saudi Journal of Biological Sciences* (2017-02) <https://doi.org/ghmwh5>  
DOI: [10.1016/j.sjbs.2016.02.012](https://doi.org/10.1016/j.sjbs.2016.02.012) · PMID: [28149178](https://pubmed.ncbi.nlm.nih.gov/28149178/) · PMCID: [PMC5272952](https://pubmed.ncbi.nlm.nih.gov/PMC5272952/)

**81. Eastern Pamirs – A vegetation-plot database for the high mountain pastures of the Pamir Plateau (Tajikistan)**

Kim André Vanselow  
*Phytocoenologia* (2016-06-01) <https://doi.org/f952sp>  
DOI: [10.1127/phyto/2016/0122](https://doi.org/10.1127/phyto/2016/0122)

**82. Socotra Vegetation Database**

Michele De Sanctis, Fabio Attorre  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvct>  
DOI: [10.7809/b-e.00111](https://doi.org/10.7809/b-e.00111)



83. **Structural and floristic diversity of mixed tropical rain forest in New Caledonia: new data from the New Caledonian Plant Inventory and Permanent Plot Network (NC-PIPPN)**  
Thomas Ibanez, Jérôme Munzinger, Gilles Dagostini, Vanessa Hequet, Frédéric Rigault, Tanguy Jaffré, Philippe Birnbaum  
*Applied Vegetation Science* (2014-07) <https://doi.org/f57bfw>  
DOI: [10.1111/avsc.12070](https://doi.org/10.1111/avsc.12070)
84. **Managing biodiversity information: development of New Zealand's National Vegetation Survey databank**  
S. K. Wiser, P. J. Bellingham, L. E. Burrows  
*New Zealand Journal of Ecology* (2001) <https://www.jstor.org/stable/24055293>
85. **Species Richness, Forest Structure, and Functional Diversity During Succession in the New Guinea Lowlands**  
Timothy J. S. Whitfeld, Jesse R. Lasky, Kipiro Damas, Gibson Sosanika, Kenneth Molem, Rebecca A. Montgomery  
*Biotropica* (2014-09) <https://doi.org/f6hf36>  
DOI: [10.1111/btp.12136](https://doi.org/10.1111/btp.12136)
86. **Database Dry Grasslands in the Nordic and Baltic Region**  
Jürgen Dengler, Solvita Rūsiņa  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcv>  
DOI: [10.7809/b-e.00114](https://doi.org/10.7809/b-e.00114)
87. **Vegetation-Plot Database of the University of the Basque Country (BIOVEG)**  
Idoia Biurrun, Itziar García-Mijangos, Juan Campos, Mercedes Herrera, Javier Loidi  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9d>  
DOI: [10.7809/b-e.00121](https://doi.org/10.7809/b-e.00121)
88. **Balkan Dry Grasslands Database**  
Kiril Vassilev, Zora Dajiš, Renata Cušterevska, Erwin Bergmeier, Iva Apostolova  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcw>  
DOI: [10.7809/b-e.00123](https://doi.org/10.7809/b-e.00123)
89. **The Mediterranean *Ammophiletea* Database: a comprehensive dataset of coastal dune vegetation**  
Corrado Marcenò, Borja Jiménez-Alfaro  
*Phytocoenologia* (2016) <https://doi.org/ghgt83>  
DOI: [10.1127/phyto/2016/0133](https://doi.org/10.1127/phyto/2016/0133)
90. **Local temperatures inferred from plant communities suggest strong spatial buffering of climate warming across Northern Europe**  
Jonathan Lenoir, Bente Jessen Graae, Per Arild Aarrestad, Inger Greve Alsos, W. Scott Armbruster, Gunnar Austrheim, Claes Bergendorff, H. John B. Birks, Kari Anne Bråthen, Jörg Brunet, ... Jens-Christian Svenning  
*Global Change Biology* (2013-05) <https://doi.org/f24bdd>  
DOI: [10.1111/gcb.12129](https://doi.org/10.1111/gcb.12129) · PMID: [23504984](https://pubmed.ncbi.nlm.nih.gov/23504984/)
91. **Balkan Vegetation Database: historical background, current status and future perspectives**  
Kiril Vassilev, Hristo Pedashenko, Alexandra Alexandrova, Alexandar Tashev, Anna Ganeva, Anna Gavrilova, Asya Gradevska, Assen Assenov, Antonina Vitkova, Borislav Grigorov, ... Vladimir Vulchev  
*Phytocoenologia* (2016-06-01) <https://doi.org/f8sjft>  
DOI: [10.1127/phyto/2016/0109](https://doi.org/10.1127/phyto/2016/0109)

92. **WetVegEurope: a database of aquatic and wetland vegetation of Europe**  
Flavia Landucci, Marcela Řezníčková, Kateřina Šumberová, Milan Chytrý, Liene Aunina, Claudia Biță-Nicolae, Alexander Bobrov, Lyubov Borsukevych, Henry Brisse, Andraž Čarni, ... Wolfgang Willner  
*Phytocoenologia* (2015-07-01) <https://doi.org/bdmw>  
DOI: [10.1127/phyto/2015/0050](https://doi.org/10.1127/phyto/2015/0050)
93. **European Mire Vegetation Database: a gap-oriented database for European fens and bogs**  
Tomáš Peterka, Martin Jiroušek, Michal Hájek, Borja Jiménez-Alfaro  
*Phytocoenologia* (2015-11-01) <https://doi.org/f724p4>  
DOI: [10.1127/phyto/2015/0054](https://doi.org/10.1127/phyto/2015/0054)
94. **Vegetation Database of Albania**  
Michele De Sanctis, Giuliano Fanelli, Alfred Mullaj, Fabio Attorre  
*Phytocoenologia* (2017-01-01) <https://doi.org/ghgt85>  
DOI: [10.1127/phyto/2017/0178](https://doi.org/10.1127/phyto/2017/0178)
95. **Austrian Vegetation Database**  
Wolfgang Willner, Christian Berg, Paul Heiselmayer  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcx>  
DOI: [10.7809/b-e.00125](https://doi.org/10.7809/b-e.00125)
96. **Bulgarian Vegetation Database: historic background, current status and future prospects**  
Iva Apostolova, Desislava Sopotlieva, Hristo Pedashenko, Nikolay Velez, Kiril Vasilev  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvch>  
DOI: [10.7809/b-e.00069](https://doi.org/10.7809/b-e.00069)
97. **Swiss Forest Vegetation Database**  
Thomas Wohlgemuth  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcz>  
DOI: [10.7809/b-e.00131](https://doi.org/10.7809/b-e.00131)
98. **Czech National Phytosociological Database: basic statistics of the available vegetation-plot data**  
M. Chytrý, M. Rafajová  
*Preslia* (2003)
99. **VegMV – the vegetation database of Mecklenburg-Vorpommern**  
Florian Jansen, Jürgen Dengler, Christian Berg  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/gftw54>  
DOI: [10.7809/b-e.00070](https://doi.org/10.7809/b-e.00070)
100. **VegetWeb – the national online-repository of vegetation plots from Germany**  
Jörg Ewald, Rudolf May, Martin Kleikamp  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcj>  
DOI: [10.7809/b-e.00073](https://doi.org/10.7809/b-e.00073)
101. **German Vegetation Reference Database (GVRD)**  
Ute Jandt, Helge Bruelheide  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvc2>  
DOI: [10.7809/b-e.00146](https://doi.org/10.7809/b-e.00146)
102. **The phytosociological database SOPHY as the basis of plant socio-ecology and phytoclimatology in France**



Emmanuel Garbolino, Patrice De Ruffray, Henry Brisse, Gilles Grandjouan  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghhn9q>  
DOI: [10.7809/b-e.00074](https://doi.org/10.7809/b-e.00074)

**103. Hellenic Natura 2000 Vegetation Database (HelNatVeg)**

Panayotis Dimopoulos, Ioannis Tsiripidis  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvc3>  
DOI: [10.7809/b-e.00177](https://doi.org/10.7809/b-e.00177)

**104. Hellenic Woodland Database**

Georgios Fotiadis, Ioannis Tsiripidis, Erwin Bergmeier, Panayotis Dimopolous  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvc4>  
DOI: [10.7809/b-e.00178](https://doi.org/10.7809/b-e.00178)

**105. Phytosociological Database of Non-Forest Vegetation in Croatia**

Zvezdana Stancic  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9f>  
DOI: [10.7809/b-e.00180](https://doi.org/10.7809/b-e.00180)

**106. Hungarian Phytosociological database (COENODATREF): sampling methodology, nomenclature and its actual stage**

K Lájér, Z. Botta-Dukát, J. Csiky, F. Horváth, F. Szmorad, I. Bagi, T. Rédei  
*Annali di Botanica, Nuova Serie* (2008)

**107. VegItaly: The Italian collaborative project for a national vegetation database**

F. Landucci, A. T. R. Acosta, E. Agrillo, F. Attorre, E. Biondi, V. E. Cambria, A. Chiarucci, E. Del Vico, M. De Sanctis, L. Facioni, ... R. Venanzoni  
*Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology* (2012-12)  
<https://doi.org/ghgt8x>  
DOI: [10.1080/11263504.2012.740093](https://doi.org/10.1080/11263504.2012.740093)

**108. Italian National Vegetation Database (BVN/ISPRA)**

Laura Casella, Pietro Massimiliano Bianco, Pierangela Angelini, Emi Morroni  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvc6>  
DOI: [10.7809/b-e.00192](https://doi.org/10.7809/b-e.00192)

**109. Nationwide Vegetation Plot Database – Sapienza University of Rome: state of the art, basic figures and future perspectives**

Emiliano Agrillo\*, Nicola Alessi, Marco Massimi, Francesco Spada, Michele De Sanctis  
*Phytocoenologia* (2017-07-20) <https://doi.org/gbsxm9>  
DOI: [10.1127/phyto/2017/0139](https://doi.org/10.1127/phyto/2017/0139)

**110. Semi-natural Grassland Vegetation Database of Latvia**

Solvita Rūsiņa  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9g>  
DOI: [10.7809/b-e.00197](https://doi.org/10.7809/b-e.00197)

**111. Schatten voor de natuur. Achtergronden, inventaris en toepassingen van de Landelijke Vegetatie Databank**

J. H. J. Schaminée, J. A. M. Janssen, R. Haveman, S. M. Hennekens, G. B. M. Heuvelink, H. P. J. Huiskes, E. J. Weeda  
*KNNV Uitgeverij* (2006)

112. **The Polish Vegetation Database: structure, resources and development**  
Zygmunt Kaćki, Michał Śliwiński  
*Acta Societatis Botanicorum Poloniae* (2012) <https://doi.org/f34f3k>  
DOI: [10.5586/asbp.2012.014](https://doi.org/10.5586/asbp.2012.014)
113. **Romanian Forest Database: a phytosociological archive of woody vegetation**  
Adrian Indreica, Pavel Dan Turtureanu, Anna Szabó, Irina Irimia  
*Phytocoenologia* (2017-12-01) <https://doi.org/ghgt86>  
DOI: [10.1127/phyto/2017/0201](https://doi.org/10.1127/phyto/2017/0201)
114. **The Romanian Grassland Database (RGD): historical background, current status and future perspectives**  
Kiril Vassilev, Eszter Ruprecht, Valeriu Alexiu, Thomas Becker, Monica Beldean, Claudia Biță-Nicolae, Anna Mária Csörgő, Iliana Dzhovanova, Eva Filipova, József Pál Frink, ... Jürgen Dengler  
*Phytocoenologia* (2018-03-01) <https://doi.org/gc79hp>  
DOI: [10.1127/phyto/2017/0229](https://doi.org/10.1127/phyto/2017/0229)
115. **Vegetation Database Grassland Vegetation of Serbia**  
Svetlana Ačić, Milicia Petrović, Urban Šilc, Zora Dajić Stevanović  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9h>  
DOI: [10.7809/b-e.00206](https://doi.org/10.7809/b-e.00206)
116. **Lower Volga Valley Phytosociological Database**  
Alexey Sorokin, Valentin Golub, Kseniya Starichkova, Lyudmila Nikolaychuk, Viktoria Bondareva, Tatyana Ivakhnova  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9j>  
DOI: [10.7809/b-e.00207](https://doi.org/10.7809/b-e.00207)
117. **Vegetation Database of the Volga and the Ural Rivers Basins**  
Tatiana Lysenko, Olga Kalmykova, Anna Mitroshenkova  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvc7>  
DOI: [10.7809/b-e.00208](https://doi.org/10.7809/b-e.00208)
118. **Vegetation Database of Tatarstan**  
Vadim Prokhorov, Tatiana Rogova, Maria Kozhevnikova  
*Phytocoenologia* (2017-09-27) <https://doi.org/ghgt84>  
DOI: [10.1127/phyto/2017/0172](https://doi.org/10.1127/phyto/2017/0172)
119. **Vegetation Database of Slovenia**  
Urban Šilc  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9k>  
DOI: [10.7809/b-e.00215](https://doi.org/10.7809/b-e.00215)
120. **Slovak Vegetation Database**  
Jozef Šibík  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgt9m>  
DOI: [10.7809/b-e.00216](https://doi.org/10.7809/b-e.00216)
121. **Ukrainian Grasslands Database**  
Anna Kuzemko  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghk7f3>  
DOI: [10.7809/b-e.00217](https://doi.org/10.7809/b-e.00217)

122. **The Tree Biodiversity Network (BIOTREE-NET): prospects for biodiversity research and conservation in the Neotropics**  
Luis Cayuela, Lucía Gálvez-Bravo, Ramón Pérez Pérez, Fábio de Albuquerque, Duncan Golicher, Rakan Zahawi, Neptalí Ramírez-Marcial, Cristina Garibaldi, Richard Field, José Rey Benayas, ... Regino Zamora  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvck>  
DOI: [10.7809/b-e.00078](https://doi.org/10.7809/b-e.00078)
123. **Timberline meadows along a 1000-km transect in NW North America: species diversity and community patterns**  
Viktoria Wagner, Toby Spribille, Stefan Abrahamczyk, Erwin Bergmeier  
*Applied Vegetation Science* (2014-01) <https://doi.org/f5mpvm>  
DOI: [10.1111/avsc.12045](https://doi.org/10.1111/avsc.12045)
124. **How resilient are northern hardwood forests to human disturbance? An evaluation using a plant functional group approach**  
I. Aubin, S. Gachet, C. Messier, A. Bouchard  
*Ecoscience* (2007)
125. **Vegetation and altitudinal zonation in continental West Greenland**  
B. Sieg, B. Drees, F. J. A. Daniëls  
*Meddelelser om Grønland Bioscience* (2006)
126. **VegBank – a permanent, open-access archive for vegetation-plot data**  
Robert Peet, Michael Lee, Michael Jennings, Don Faber-Langendoen  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcm>  
DOI: [10.7809/b-e.00080](https://doi.org/10.7809/b-e.00080)
127. **Vegetation-plot database of the Carolina Vegetation Survey**  
Robert Peet, Michael Lee, Forbes Boyle, Thomas Wentworth, Michael Schafale, Alan Weakley  
*Biodiversity & Ecology* (2012-09-10) <https://doi.org/ghgvcn>  
DOI: [10.7809/b-e.00081](https://doi.org/10.7809/b-e.00081)
128. **The Alaska Arctic Vegetation Archive (AVA-AK)**  
Donald A. Walker, Amy L. Breen, Lisa A. Druckenmiller, Lisa W. Wirth, Will Fisher, Martha K. Reynolds, Jozef Šibík, Marilyn D. Walker, Stephan Hennekens, Keith Boggs, ... Donatella Zona  
*Phytocoenologia* (2016-09-01) <https://doi.org/f877ht>  
DOI: [10.1127/phyto/2016/0128](https://doi.org/10.1127/phyto/2016/0128)
129. **VegPáramo, a flora and vegetation database for the Andean páramo**  
Gwendolyn Peyre, Henrik Balslev, David Martí, Petr Sklenář, Paul Ramsay, Pablo Lozano, Nidia Cuello, Rainer Bussmann, Omar Cabrera, Xavier Font  
*Phytocoenologia* (2015-07-01) <https://doi.org/f7m9cj>  
DOI: [10.1127/phyto/2015/0045](https://doi.org/10.1127/phyto/2015/0045)
130. **Insights from a large-scale inventory in the southern Brazilian Atlantic Forest**  
Alexander Christian Vibrans, André Luís de Gasper, Paolo Moser, Laio Zimmermann Oliveira, Débora Vanessa Lingner, Lucia Sevegnani  
*Scientia Agricola* (2020) <https://doi.org/ghqcn6>  
DOI: [10.1590/1678-992x-2018-0036](https://doi.org/10.1590/1678-992x-2018-0036)
131. **Plant Invasions in Protected Areas**  
Springer Science and Business Media LLC

(2013) <https://doi.org/ghgt8v>  
DOI: [10.1007/978-94-007-7750-7](https://doi.org/10.1007/978-94-007-7750-7)

# Supplementary Material

**Table 1:** List of databases contributing to sPlotOpen, the environmentally-balanced, open-access, global dataset of vegetation plots. Databases are ordered based on their ID in the Global Index of Vegetation Databases (GVID ID).

GVID ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
00-00-001	ForestPlots.net	Oliver L. Phillips	Aurora Levesley	169	<a href="#">59</a>
00-00-003	SALVIAS	Brian Enquist	Brad Boyle	3403	
00-00-004	Vegetation Database of Eurasian Tundra	Risto Virtanen		519	
00-00-005	Tundra Vegetation Plots (TundraPlot)	Anne D. Bjorkman	Sarah Elmendorf	309	<a href="#">60</a>
00-RU-001	Vegetation Database Forest of Southern Ural	Vasiliy Martynenko	Pavel Shirokikh	68	
00-RU-002	Database of Masaryk University`s Vegetation Research in Siberia	Milan Chytrý		158	<a href="#">61</a>
00-RU-003	Database Meadows and Steppes of Southern Ural	Sergey Yamalov	Mariya Lebedeva	238	
00-TR-001	Forest Vegetation Database of Turkey - FVDT	Ali Kavgacı		45	
AF-00-001	West African Vegetation Database	Marco Schmidt	Georg Zizka	258	<a href="#">62</a>
AF-00-003	BIOTA Southern Africa Biodiversity Observatories Vegetation Database	Norbert Jürgens	Ute Schmiedel	1015	<a href="#">63</a>
AF-00-006	SWEA-Dataveg	Miguel Alvarez	Michael Curran	1675	
AF-00-008	PANAF Vegetation Database	Hjalmar S. Kühl	TeneKwetché Sop	884	
AF-00-009	Vegetation Database of the Okavango Basin	Rasmus Revermann	Manfred Finckh	378	<a href="#">64</a>
AF-BF-001	Sahel Vegetation Database	Jonas V. Müller	Marco Schmidt	556	<a href="#">65</a>
AF-CD-001	Forest Database of Central Congo Basin	Kim Sarah Jacobsen	Hans Verbeeck	140	<a href="#">66</a>
AF-ET-001	Vegetation Database of Ethiopia	Desalegn Wana	Anke Jentsch	67	<a href="#">67</a>
AF-MA-001	Vegetation Database of Southern Morocco	Manfred Finckh		621	<a href="#">68</a>
AF-ZW-001	Vegetation Database of Zimbabwe	Cyrus Samimi		31	<a href="#">69</a>
AS-00-001	Korean Forest Database	Tomáš Černý	Jiri Dolezal	1039	<a href="#">70</a>
AS-00-003	Vegetation of Middle Asia	Arkadiusz Nowak	Marcin Nobis	314	<a href="#">71</a>
AS-00-004	Rice Field Vegetation Database	Arkadiusz Nowak		32	
AS-BD-001	Tropical Forest Dataset of Bangladesh	Mohammed A.S. Arfin Khan	Fahmida Sultana	87	
AS-CN-001	China Forest-Steppe Ecotone Database	Hongyan Liu	Fengjun Zhao	117	<a href="#">72</a>
AS-CN-002	Tibet-PaDeMoS Grazing Transect	Karsten Wesche		58	<a href="#">73</a>
AS-CN-003	Vegetation Database of the BEF China Project	Helge Brühlheide		24	<a href="#">74</a>

<b>GIVD ID</b>	<b>Dataset name</b>	<b>Custodian</b>	<b>Deputy custodian</b>	<b>Nr. open-access plots</b>	<b>Ref</b>
AS-CN-004	Vegetation Database of the Northern Mountains in China	Zhiyao Tang		124	
AS-EG-001	Vegetation Database of Sinai in Egypt	Mohamed Z. Hatim		143	<a href="#">75</a>
AS-ID-001	Sulawesi Vegetation Database	Michael Kessler		24	
AS-IR-001	Vegetation Database of Iran	Jalil Noroozi	Parastoo Mahdavi	277	
AS-KZ-001	Database of Meadow Vegetation in the NW Tien Shan Mountains	Viktoria Wagner		13	<a href="#">76</a>
AS-MN-001	Southern Gobi Protected Areas Database	Henrik von Wehrden	Karsten Wesche	1032	<a href="#">77</a>
AS-RU-001	Wetland Vegetation Database of Baikal Siberia (WETBS)	Victor Chepinoga		9	<a href="#">78</a>
AS-RU-002	Database of Siberian Vegetation (DSV)	Andrey Korolyuk	Andrei Zverev	3634	<a href="#">79</a>
AS-RU-004	Database of the University of Münster - Biodiversity and Ecosystem Research Group's Vegetation Research in Western Siberia and Kazakhstan	Norbert Hölzel	Wanja Mathar	207	
AS-SA-001	Vegetation Database of Saudi Arabia	Mohamed Abd El-Rouf Mousa El-Sheikh		711	<a href="#">80</a>
AS-TJ-001	Eastern Pamirs	Kim André Vanselow		221	<a href="#">81</a>
AS-TW-001	National Vegetation Database of Taiwan	Ching-Feng Li	Chang-Fu Hsieh	912	
AS-YE-001	Socotra Vegetation Database	Michele De Sanctis	Fabio Attorre	236	<a href="#">82</a>
AU-AU-002	AEKOS	Ben Sparrow		10976	<a href="#">36</a>
AU-NC-001	New Caledonian Plant Inventory and Permanent Plot Network (NC-PIPPN)	Jérôme Munzinger	Philippe Birnbaum	98	<a href="#">83</a>
AU-NZ-001	New Zealand National Vegetation Databank	Susan K. Wiser		1127	<a href="#">84</a>
AU-PG-001	Forest Plots from Papua New Guinea	Timothy J.S. Whitfeld	George D. Weiblen	60	<a href="#">85</a>
EU-00-002	Nordic-Baltic Grassland Vegetation Database (NBGVD)	Jürgen Dengler	Łukasz Kozub	54	<a href="#">86</a>
EU-00-011	Vegetation-Plot Database of the University of the Basque Country (BIOVEG)	Idoia Biurrun	Itziar García-Mijangos	2142	<a href="#">87</a>
EU-00-013	Balkan Dry Grasslands Database	Kiril Vassilev	Armin Macanović	269	<a href="#">88</a>
EU-00-016	Mediterranean Ammophiletea Database	Corrado Marcenò	Borja Jiménez-Alfaro	783	<a href="#">89</a>
EU-00-017	European Coastal Vegetation Database	John A.M. Janssen		356	
EU-00-018	The Nordic Vegetation Database	Jonathan Lenoir	Jens-Christian Svenning	1735	<a href="#">90</a>

<b>GIVD ID</b>	<b>Dataset name</b>	<b>Custodian</b>	<b>Deputy custodian</b>	<b>Nr. open-access plots</b>	<b>Ref</b>
EU-00-019	Balkan Vegetation Database	Kiril Vassilev	Hristo Pedashenko	484	<a href="#">91</a>
EU-00-020	WetVegEurope	Flavia Landucci		127	<a href="#">92</a>
EU-00-022	European Mire Vegetation Database	Tomáš Peterka	Martin Jiroušek	2560	<a href="#">93</a>
EU-AL-001	Vegetation Database of Albania	Michele De Sanctis	Giuliano Fanelli	31	<a href="#">94</a>
EU-AT-001	Austrian Vegetation Database	Wolfgang Willner	Christian Berg	2310	<a href="#">95</a>
EU-BE-002	INBOVEG	Els De Bie		119	
EU-BG-001	Bulgarian Vegetation Database	Iva Apostolova	Desislava Sopotlieva	160	<a href="#">96</a>
EU-CH-005	Swiss Forest Vegetation Database	Thomas Wohlgemuth		2134	<a href="#">97</a>
EU-CZ-001	Czech National Phytosociological Database	Milan Chytrý	Ilona Knollová	1287	<a href="#">98</a>
EU-DE-001	VegMV	Florian Jansen	Christian Berg	15	<a href="#">99</a>
EU-DE-013	VegetWeb Germany	Florian Jansen	Jörg Ewald	587	<a href="#">100</a>
EU-DE-014	German Vegetation Reference Database (GVRD)	Ute Jandt	Helge Bruelheide	762	<a href="#">101</a>
EU-DK-002	National Vegetation Database of Denmark	Jesper Erenskjold Moeslund	Rasmus Ejrnæs	332	
EU-ES-001	Iberian and Macaronesian Vegetation Information System (SIVIM) - Wetlands	Aaron Pérez-Haase	Xavier Font	580	
EU-FR-003	SOPHY	Emmanuel Garbolino	Patrice De Ruffray	7986	<a href="#">102</a>
EU-GB-001	UK National Vegetation Classification Database	John S. Rodwell		3182	
EU-GR-001	KRITI	Erwin Bergmeier		22	
EU-GR-005	Hellenic Natura 2000 Vegetation Database (HelNatVeg)	Panayotis Dimopoulos	Ioannis Tsiripidis	620	<a href="#">103</a>
EU-GR-006	Hellenic Woodland Database	Ioannis Tsiripidis	Georgios Fotiadis	17	<a href="#">104</a>
EU-HR-001	Phytosociological Database of Non-Forest Vegetation in Croatia	Zvezdana Stančić		193	<a href="#">105</a>
EU-HR-002	Croatian Vegetation Database	Željko Škvorc	Daniel Krstonošić	585	
EU-HU-003	CoenoDat Hungarian Phytosociological Database	János Csiky	Zoltán Botta-Dukát	46	<a href="#">106</a>
EU-IT-001	VegItaly	Roberto Venanzoni	Flavia Landucci	754	<a href="#">107</a>
EU-IT-010	Vegetation database of Habitats in the Italian Alps – HabItAlp	Laura Casella	Pierangela Angelini	247	<a href="#">108</a>
EU-IT-011	Vegetation-Plot Database Sapienza University of Rome (VPD-Sapienza)	Emiliano Agrillo	Fabio Attorre	967	<a href="#">109</a>
EU-LT-001	Lithuanian Vegetation Database	Valerijus Rašomavičius	Domas Uogintas	81	

<b>GIVD ID</b>	<b>Dataset name</b>	<b>Custodian</b>	<b>Deputy custodian</b>	<b>Nr. open-access plots</b>	<b>Ref</b>
EU-LV-001	Semi-natural Grassland Vegetation Database of Latvia	Solvita Rūsiņa		369	<a href="#">110</a>
EU-MK-001	Vegetation Database of the Republic of Macedonia	Renata Ćušterevska		28	
EU-NL-001	Dutch National Vegetation Database	Stephan M. Hennekens	Joop H.J. Schaminée	1098	<a href="#">111</a>
EU-PL-001	Polish Vegetation Database	Zygmunt Kącki	Grzegorz Swacha	692	<a href="#">112</a>
EU-RO-007	Romanian Forest Database	Adrian Indreica	Pavel Dan Turtureanu	166	<a href="#">113</a>
EU-RO-008	Romanian Grassland Database	Eszter Ruprecht	Kiril Vassilev	82	<a href="#">114</a>
EU-RS-002	Vegetation Database Grassland Vegetation of Serbia	Svetlana Ačić	Zora Dajić Stevanović	217	<a href="#">115</a>
EU-RU-002	Lower Volga Valley Phytosociological Database	Valentin Golub	Andrey Chuvashov	383	<a href="#">116</a>
EU-RU-003	Vegetation Database of the Volga and the Ural Rivers Basins	Tatiana Lysenko		174	<a href="#">117</a>
EU-RU-011	Vegetation Database of Tatarstan	Vadim Prokhorov	Maria Kozhevnikova	206	<a href="#">118</a>
EU-SI-001	Vegetation Database of Slovenia	Urban Šilc	Filip Kuzmič	1029	<a href="#">119</a>
EU-SK-001	Slovak Vegetation Database	Milan Valachovič	Jozef Šibík	2394	<a href="#">120</a>
EU-UA-001	Ukrainian Grasslands Database	Anna Kuzemko	Yulia Vashenyak	301	<a href="#">121</a>
EU-UA-006	Vegetation Database of Ukraine and Adjacent Parts of Russia	Viktor Onyshchenko	Vitaliy Kolomiychuk	96	
NA-00-002	Tree Biodiversity Network (BIOTREE-NET)	Luis Cayuela		241	<a href="#">122</a>
NA-CA-003	Database of Timberline Vegetation in NW North America	Viktoria Wagner	Toby Spribille	63	<a href="#">123</a>
NA-CA-004	Understory of Sugar Maple Dominated Stands in Quebec and Ontario (Canada)	Isabelle Aubin		13	<a href="#">124</a>
NA-CA-005	Boreal Forest of Canada	Philippe Marchand	Yves Bergeron	57	
NA-GL-001	Vegetation Database of Greenland	Birgit Jedrzejek	Fred J.A. Daniëls	441	<a href="#">125</a>
NA-US-002	VegBank	Robert K. Peet	Michael T. Lee	14965	<a href="#">126</a>
NA-US-006	Carolina Vegetation Survey Database	Robert K. Peet	Michael T. Lee	3263	<a href="#">127</a>
NA-US-014	Alaska-Arctic Vegetation Archive	Donald A. Walker	Amy Breen	771	<a href="#">128</a>
SA-00-002	VegPáramo	Gwendolyn Peyre	Xavier Font	2010	<a href="#">129</a>
SA-AR-002	Vegetation Database of Central Argentina	Melisa Giorgis	Alicia T.R. Acosta	86	
SA-BO-003	Bolivia Forest Plots	Michael Kessler	Sebastian Herzog	44	
SA-BR-002	Forest Inventory, State of Santa Catarina, Brazil (IFFSC Project)	Alexander Christian Vibrans	André Luís de Gasper	1561	<a href="#">130</a>



GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
SA-BR-003	Grasslands of Rio Grande do Sul, Brazil	Eduardo Vélez-Martin	Valério D. Pillar	306	
SA-BR-004	Grassland Database of Campos Sulinos	Gerhard E. Overbeck	Valério D. Pillar	147	
SA-CL-002	SSAForests_Plots_db	Alvaro G. Gutiérrez		155	
SA-CL-003	Chilean Park Transects - Fondecyt 1040528	Aníbal Pauchard	Alicia Marticorena	44	<a href="#">131</a>
SA-EC-001	Ecuador Forest Plot Database	Jürgen Homeier		166	

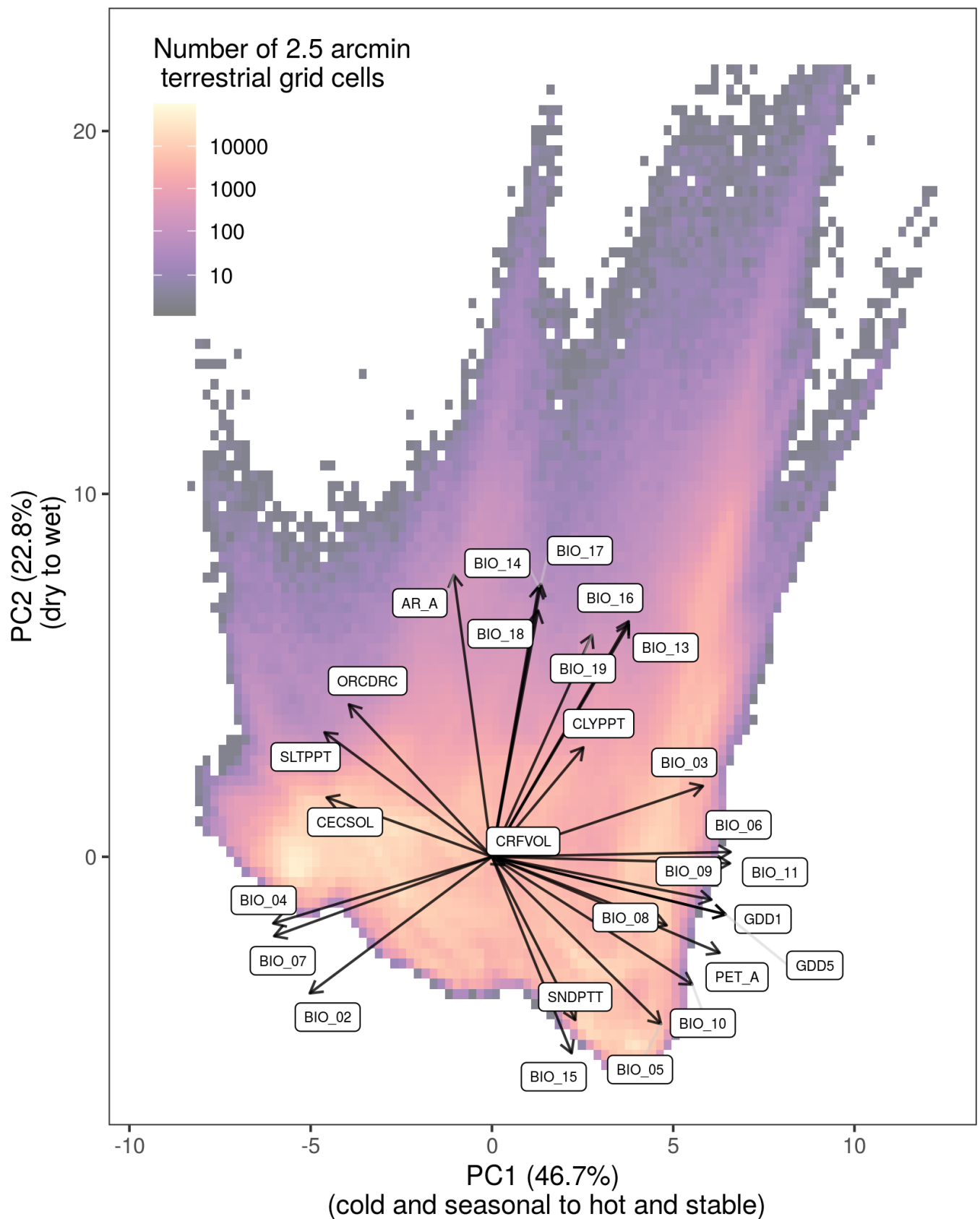
**Table 2:** Description of the variables contained in the ‘header’ matrix, together with their range (if numeric) or possible levels (if nominal or binary) and the number of non-empty (i.e., non NA) records. Variable types can be n - nominal (i.e., qualitative variable), o - ordinal, q - quantitative, or b - binary (i.e., boolean), or d - date . Additional details on the variables are in Bruelheide et al. (2019) [[23](#)]. GIVD codes derive from Dengler et al. (2011) [[37](#)]. Biomes refer to Schultz 2005 [[49](#)], modified to include also the world mountain regions by Körner et al. (2017)[[50](#)]. The column ESY refers to the EUNIS Habitat Classification Expert system described in Chytrý et al. (2020) [[53](#)].

Variable	Range/Levels	Unit of Measurement	Nr. of plots with information	Type
GIVD_ID			95104	n
Dataset			95104	n
Continent	Africa, Asia, Europe, North America, Oceania, South America		95104	n
Country			95104	n
Biome	Alpine, Boreal zone, Dry midlatitudes, Dry tropics and subtropics, Polar and subpolar zone, Subtropics with year-round rain, Subtropics with winter rain, Temperate midlatitudes, Tropics with summer rain, Tropics with year-round rain		95104	n
Date_of_recording	1888-07-05 - 2015-02-03	dd-mm-yyyy	80085	d
Latitude	-54.82303 - 80.149116	° (WGS84)	95104	q
Longitude	-162.741433 - 176.4221	° (WGS84)	95104	q
Location_uncertainty	1 - 2750	m	95075	q
Releve_area	0.03 - 40000	m <sup>2</sup>	67022	q
Plant_recorded	All vascular plants, All trees & dominant understory, Dominant trees, Only dominant species, Dominant woody plants >= 2.5 cm dbh, All woody plants, Woody plants >= 1 cm dbh, Woody plants >= 2.5 cm dbh, Woody plants >= 5 cm dbh, Woody plants >= 10 cm dbh, Woody plants >= 20 cm dbh, Woody plants >= 1 m height, Not specified		95104	n
Elevation	-30 - 5960	m a.s.l.	62968	q
Aspect	1 - 360	°	42178	q

<b>Variable</b>	<b>Range/Levels</b>	<b>Unit of Measurement</b>	<b>Nr. of plots with information</b>	<b>Type</b>
Slope	0 - 90	°	51246	q
is_forest	FALSE = 45735; TRUE = 38282		84017	b
ESY			39632	n
Naturalness	1 = Natural, 2 = Semi-natural		60192	o
Forest	FALSE = 36282; TRUE = 33170		69452	b
Shrubland	FALSE = 58245; TRUE = 11207		69452	b
Grassland	FALSE = 33800; TRUE = 35652		69452	b
Wetland	FALSE = 59196; TRUE = 10256		69452	b
Sparse_vegetation	FALSE = 66177; TRUE = 3275		69452	b
Cover_total	1 - 990	%	19407	q
Cover_tree_layer	0.5 - 150	%	12094	q
Cover_shrub_layer	0.5 - 170	%	16804	q
Cover_herb_layer	0.2 - 199	%	29668	q
Cover_moss_layer	1 - 100	%	9681	q
Cover_lichen_layer	1 - 90	%	708	q
Cover_algae_layer	1 - 100	%	41	q
Cover_litter_layer	1 - 107	%	3161	q
Cover_bare_rocks	1 - 100	%	2747	q
Cover_cryptogams	1 - 90	%	772	q
Cover_bare_soil	-1 - 99	%	2746	q
Height_trees_highest	1 - 99	m	8220	q
Height_trees_lowest	1 - 90	m	447	q
Height_shrubs_highest	0.1 - 9.9	m	3389	q
Height_shrubs_lowest	0.1 - 9	m	263	q
Height_herbs_average	0.1 - 600	cm	5901	q
Height_herbs_lowest	1 - 150	cm	490	q
Height_herbs_highest	1 - 600	cm	1083	q
SoilClim_PC1	-6.233 - 8.172		95104	q
SoilClim_PC2	-4.824 - 15.466		95104	q
Resample_1	FALSE = 45317; TRUE = 49787		95104	b
Resample_2	FALSE = 45293; TRUE = 49811		95104	b
Resample_3	FALSE = 45315; TRUE = 49789		95104	b
Resample_1_consensus	FALSE = 41842; TRUE = 53262		95104	b

## Supplementary Material

Figure S1



**Figure S1:** Global principal component analysis (PCA) of the world environmental conditions. The PCA is based on the matrix of all terrestrial grid cells ( $n = 8,384,404$ , spatial grain = 2.5 arcmin) by 30 environmental variables. The PCA space

represents the full environmental space of all terrestrial habitats on Earth, irrespective of whether a grid cell hosted vegetation plots from the sPlotOpen or not. The PCA space is divided into a 10,000 regular tiles (100 x 100), and the number of 2.5 arcmin terrestrial grid cells counted for each tile. Abbreviations - Climate - Bio1 = Annual Mean Temperature, Bio2 = Mean Diurnal Range, Bio3 = Isothermality, Bio4 = Temperature Seasonality, Bio5 = Max Temperature of Warmest Month, Bio6 = Min Temperature of Coldest Month, Bio7 = Temperature Annual Range, Bio8 = Mean Temperature of Wettest Quarter, Bio9 = Mean Temperature of Driest Quarter, Bio10 = Mean Temperature of Warmest Quarter, Bio11 = Mean Temperature of Coldest Quarter, Bio12 = Annual Precipitation, Bio13 = Precipitation of Wettest Month, Bio14 = Precipitation of Driest Month, Bio15 = Precipitation Seasonality, Bio16 = Precipitation of Wettest Quarter, Bio17 = Precipitation of Driest Quarter, Bio18 = Precipitation of Warmest Quarter, Bio19 = Precipitation of Coldest Quarter. Soil - CEC SOL = Cation Exchange capacity of soil, ORCDRC = Soil Organic Carbon Content, PHIHOX = Soil pH, BLDFIE = Bulk Density, CLYPPT = Clay mass fraction, SLTPPT = Silt mass fraction, SNDPPT = Sand mass fraction, CRFVOL = Coarse fragments.