sPlot open - 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@543eedc] on December 16, 2020.

Authors

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

✉ — To whom correspondence should be addressed: francesco.sabatini@botanik.uni-halle.de
† — These authors contributed equally to this work

1. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Puschstrasse 4, 04103, Leipzig, Germany

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, University of 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, Strasburg, 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. Sapienza University of Rome, Department of Environmental Biology, P.le Aldo Moro 5, 00185, 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. Canadian Forest Service, Natural Resources Canada, Great Lakes Forestry Centre, 1219 Queen St. East, P6A 2E5, Sault Ste Marie (Ontario), Canada
28. University of Illinois Urbana Champaign, Department of Computer Science, 201 North Goodwin Avenue MC 258, Urbana, IL 61801, 61801.0, Urbana, USA
29. Ghent University, Department Green chemistry and technology, Isotope Bioscience laboratory (UGent-ISOFYS), Coupure Links 653, 9000, Ghent, Belgium
30. Ghent University, Department Environment, Computational and Applied Vegetation Ecology (UGent-CAVELab), Coupure Links 653, 9000, Ghent, Belgium
31. Université du Québec en Abitibi-Témiscamingue, Forest Research Institute, 445 boul. de l’Université, J9X5E4, Rouyn-Noranda, Canada
32. University of Göttingen, Vegetation Ecology and Phytodiversity, Untere Karspüle 2, 37073, Göttingen, Germany
33. University of the Basque Country UPV/EHU, Plant Biology and Ecology, P.O. Box 644, 48080, Bilbao, Spain
34. University of Gothenburg, Department of Biological and Environmental Sciences, Carl Skottsbergs gata 22B, 41319, Gothenburg, Sweden
35. Gothenburg Global Biodiversity Centre, Carl Skottsbergs gata 22B, 41319, Gothenburg, Sweden
36. Free University of Bozen-Bolzano, Piazza Università, 5, 39100, Bolzano, Italy
37. Institute of Ecology of the Volga River Basin, Department of Phytodiversity Problems, Komzina, 10, 445003, Toljatty, Russian Federation
38. Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Sundsvägen 3, 230 53 Alnarp, Sweden
39. Research Center of the Slovenian Academy of Sciences and Arts, Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenia
40. University of Nova Gorica, School for viticulture and enology, Vipavska 13, 5000, Nova Gorica, Slovenia
41. ISPRA - Italian National Institute for Environmental Protection and Research, Biodiversity Conservation Department, Via Vitaliano Brancati, 60, 00144, Roma, Italy
42. Universidad Rey Juan Carlos, Department of Biology and Geology, Physics and Inorganic Chemistry, c/ Tulipán s/n, 29833, Móstoles, Spain
43. Czech University of Life Sciences Prague, Department of Forest Ecology, Faculty of Forestry and Wood Sciences, Kamýcká 1176, 165 21, Praha 6 - Suchdol, Czech Republic
44. Central Siberian Botanical Garden SB RAS, Zolotodolinskaya Str. 101, 630090, Novosibirsk, Russian Federation
45. University of Pécs, Department of Ecology, Ifjúság u. 6., 7624, Pécs, Hungary

46. Faculty of Natural Sciences and Mathematics, Institute of Biology, Arhimedova 3, 1000, Skopje, Republic of Macedonia
47. Research Institute for Nature and Forest (INBO), Biotope Diversity, Havenlaan 88, bus 73, 1000, Brussels, Belgium
48. Universidade Regional de Blumenau, Rua Antonio da Veiga, 140, Blumenau, 89030-903, Brazil
49. University of Patras, Laboratory of Botany, Division of Plant Biology, Department of Biology, University Campus, 26504, Patras, Greece
50. Institute of Botany, Czech Academy of Sciences, Department of Functional Ecology, Dukelska 135, 37901, Trebon, Czech Republic
51. M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Geobotany and ecology, Tereschenkivska, 1004, Kyiv, Ukraine
52. College of Science, King Saud University, Botany and Microbiology Department, P.O. Box 2455, 11451, Riyadh, Saudi Arabia
53. Damanhour University, Botany Department, Faculty of Science, Damanhour, Egypt
54. University of Arizona, Ecology and Evolutionary Biology, 1041 E. Lowell St., AZ 85721, Tucson, United States
55. Hochschule Weihenstephan-Triesdorf, University of Applied Sciences, Hans-Carl-von-Carlowitz-Platz 3, 85354, Freising, Germany
56. Google LLC, 1600 Amphitheatre Pkwy, 94043.0, Mountain View, USA
57. University of Minnesota - Twin Cities, USA
58. University of Nottingham, School of Geography, University Park, NG7 2RD, Nottingham, United Kingdom
59. University of Hamburg, Biodiversity, Ecology and Evolution of Plants, Institute for Plant Science & Microbiology, Ohnhorststr. 18, 22609, Hamburg, Germany
60. Aix Marseille Univ, Avignon Université, CNRS, IRD, IMBE, Campus St-Jérôme Etoile, 13397, Marseille, France
61. Universidad CEU San Pablo, Laboratorio de Botánica, P.O. Box 67, 28660, Boadilla del Monte, Madrid, Spain
62. Universidad Privada Antonio Guillermo Urrelo, Laboratorio de Botánica, Jr. José Sabogal
63. Estudios Fitogeográficos del Perú, Herbario AQP, Sánchez Cerro 219, Manuel Prado, Paucarpata, Arequipa, Peru
64. Climpact Data Science (CDS), Nova Sophia - Regus Nova, 291 rue Albert Caquot, CS 40095, 06902, Sophia Antipolis Cedex, France
65. University of Mazandaran, Department of Biology, Babolsar, Iran
66. Instituto Multidisciplinario de Biología Vegetal (IMBIV-CONICET), ECOLOGÍA VEGETAL Y FITOGEOGRAFÍA, Av. Vélez Sársfield 1611, 5000, Córdoba, Argentina
67. Institute of Ecology of the Volga River Basin, Laboratory of Phytocoenology, Komzina, 10, 445003, Toljatty, Russian Federation
68. The Arctic University Museum of Norway, UiT - The Arctic University of Norway, Tromsø, Norway
69. University of Bergen, Department of Biological Sciences, Postbox 7803, Bergen, Norway
70. University of Adelaide, School of Biological Sciences, North Terrace, 5005, Adelaide, Australia
71. Universidad de Chile, Departamento de Ciencias Ambientales y Recursos Naturales Renovables, Facultad de Ciencias Agronomicas, Santa Rosa 11315, La Pintana, 8820808, Santiago, Chile
72. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Puschstraße 4, 04103, Leipzig, Germany
73. Wageningen University, Plant Ecology and Nature Conservation Group - Environmental Sciences Department, P.O. Box Postbus 47, Droevendaalsesteeg 3, 6700 AA, Wageningen, The 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'Espélidou, 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 Foresty, 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 (MPI-EVA), Primatology, Puschstrasse 4, 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, Vácrátót, Hungary
99. Naturalis Biodiversity Center, Research Group Functional Traits, Darwinweg 2, 2333 CR, Leiden, The Netherlands
00. Universidade Regional de Blumenau, Departamento de Engenharia Florestal, Rua São Paulo, 3250, 89030-000, Blumenau, Brazil
01. Peking University, College of Urban and Environmental Sciences, Yiheyuan Rd. 5, 100871, Beijing, China
02. Komarov Botanical Institute RAS, Laboratory of Vegetation Science, Prof. Popov 2, 197376, Saint-Petersburg, Russian Federation
03. 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
04. Tobolsk complex scientific station of Ural Branch RAS, Group of Ecology of Living Organisms, Academician Yu. Osipov str. 15, 626152, Tobolsk, Russian Federation
05. Leipzig University, Remote Sensing Centre for Earth System Research, Talstr. 6b, 07745, Leipzig, Germany
06. Ufa Federal Scientific Center of the Russian Academy of Sciences, Institute of Biology, prospekt Oktyabrya, 69, 450054, Ufa, Russian Federation
07. Aarhus University, Department of Bioscience, Grenaavej 14, 8410, Roende, Denmark
08. Jardín Botánico de Missouri Oxapampa, Bolognesi Mz-E-6, Oxapampa, Pasco, Peru
09. Murdoch University, Harry Butler Institute, 90 South Street, Building 390, 6150, Murdoch, Australia
10. Royal Botanic Gardens, Kew, Conservation Science, Wakehurst Place, RH17 6TN, Ardingly, West Sussex, United Kingdom
11. AMAP, Université de Montpellier, CIRAD, CNRS, INRAE, IRD, 34000, Montpellier, France
12. University of Mazandaran, Department of Plant Biology, P.O. Box 47416-95447, Mazandaran, Iran
13. University of Vienna, Department of Botany and Biodiversity Research, Rennweg 14, 1030, Vienna, Austria
14. Polish Academy of Sciences, Botanical Garden - Center for Biodiversity Conservation, Prawdziwka 2, 02-950, Warsaw, Poland
15. University of Opole, Institute of Biology, Oleska St. 52, 45-052, Opole, Polska
16. National Academy of Sciences of Ukraine, M.G. Kholodny Institute of Botany, Tereshchenkivska 2, 01601, Kyiv, Ukraine
17. Universidade Federal do Rio Grande do Sul, Department of Botany, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, Brazil
18. University of Tartu, Institute of Ecology and Earth Sciences, Lai 40, 51005, Tartu, Estonia
19. Universidad de Concepción, Laboratorio de Invasiones Biológicas (LIB). Facultad de Ciencias Forestales., Victoria 631, 4030000, Concepción, Chile
20. Institute of Ecology and Biodiversity (IEB), Chile
21. University of North Carolina, Department of Biology, CB3280, South Road, 27599-3280, Chapel Hill, NC, United States
22. CSIC, Global Ecology Unit CSIC-CREAF-UAB, Edifici C, Campus UAB, 08193, Bellaterra, Spain
23. CREAF, Edifici C, 08193, Cerdanyola del Valles, Espanya
24. University of Vic-Central University of Catalonia, Department of Biosciences, Carrer de la Laura, 13, 08500, Vic, Barcelona, Spain
25. University of Barcelona, Department of Evolutionary Biology, Ecology and Environmental Sciences, Diagonal 643, 08028, Barcelona, Spain
26. Czech Academy of Sciences, Department of vegetation ecology, Institute of Botany, Zámek 1, 25243, Průhonice, Czech Republic
27. University of the Andes, Department of Civil and Environmental Engineering, Carrera 1 Este No. 19A-40, Edificio Mario Laserna, Piso 6 , 111711, Bogota, Colombia
28. Kazan Federal University, Institute of Environmental Sciences, Kremlevskaya 18, 420008, Kazan, Russian Federation
29. Nature Research Centre, Institute of Botany, Zaliuju Ezeru 49, 08406, Vilnius, Lithuania
30. University of Hamburg, Biodiversity, Ecology and Evolution of Plants/Institute for Plant Science & Microbiology, Ohnhorststr. 18, 22609, Hamburg, Germany
31. Namibia University of Science and Technology, Faculty of Natural Resources and Spatial Sciences, Windhoek, Namibia
32. Universidad San Francisco de Quito, COCIBA, Diego de Robles, 170177, Quito, Ecuador
33. 7 Derwent Road, LA1 3ES, Lancaster, United Kingdom
34. Babeș-Bolyai University, Hungarian Department of Biology and Ecology, Faculty of Biology and Geology, Republicii street 42., 400015, Cluj-Napoca, Romania
35. University of Latvia, Faculty of Geography and Earth Sciences, Jelgavas iela 1, LV 1004, Riga, Latvia

36. University of Bayreuth, Climatology, Bayreuth Center of Ecology and Environmental Research (BayCEER), Universitätsstr. 30, 95447, Bayreuth, Germany
37. Stadt Frankfurt am Main - Der Magistrat, Palmengarten, Siesmayerstraße 61, 60323, Frankfurt am Main, Germany
38. Microsoft, One Microsoft Way, 98052.0, Redmond, WA, United States
39. Plant Science and Biodiversity Centre Slovak Academy of Sciences, Institute of Botany, Dubravska cesta 9, 84523, Bratislava, Slovakia
40. Research Centre of Slovenian Academy of Sciences and Arts (ZRC SAZU), Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenia
41. Department of Botany, Charles University, Benatska 2, 12801 Prague, Czech Repunlic
42. University of Zagreb, Faculty of Forestry, Svetošimunska 25, 10000, Zagreb, Croatia
43. University of Adelaide, TERN, North Terrace, 5005, Adelaide, Australia
44. CSIC-UV-GV, Centro de Investigaciones sobre Desertificación, Carretera Moncada–Náquera km 4.5, 46113.0, Moncada (Valencia), Spain
45. University of Zagreb, Faculty of Geotechnical Engineering, Hallerova aleja 7, 42000, Varaždin, Croatia
46. Aarhus University, Department of Biology, Ny Munkegade 114, DK-8000, Aarhus C, Denmark
47. Yunnan University, School of Ecology and Environmental Science, Building Shixun, Chenggong Campus, Dongwaihuan South Road, University Town, Chenggong New District, 650504, Kunming, China
48. Aristotle University of Thessaloniki, School of Biology, 54124, Thessaloniki, Greece
49. University of Erlangen-Nuremberg, Department of Geography, Wetterkreuz 15, 91058, Erlangen, Germany
50. ILEX Consultoria Científica, Amelia Telles 184, 9.046007E7, Porto Alegre, Brazil
51. University of Perugia, Department of Chemistry, Biology and Biotechnology, Borgo XX giugno 74, 06124, Perugia, Italy
52. Univ Montpellier, CNRS, EPHE, IRD, Univ Paul Valéry Montpellier 3, CEFE, 1919 route de Mende, 34293, Montpellier, France
53. University of Oulu, Ecology and Genetics Research Unit, Biodiversity Unit, Kaitoväylä 5, 90014, Oulu, Finland
54. Helmholtz Center for Environmental Research - UFZ, Department of Physiological Diversity, Permoserstr. 15, 04318, Leipzig, Germany
55. Leuphana University of Lüneburg, Institute of Ecology, Universitätsallee 1, 21335, Lüneburg, Germany
56. University of Alberta, Department of Biological Sciences, Biological Sciences Building, T6G2E9, Edmonton, Canada
57. University of Alaska, Institute of Arctic Biology, P. O. Box 7570000, 99775, Fairbanks, United States
58. University of Wisconsin-Madison, Botany, 430 Lincoln Drive, 53706, Madison, United States
59. Hainan University, Hainan Key Laboratory for Sustainable Utilization of Tropical Bioresources, College of Tropical Crops, 58 Renmin Avenue, Meilan District, 570228, Haikou, China
60. Senckenberg Museum of Natural History Görlitz, Botany Department, PO Box 300 154, 02806, Görlitz, Germany
61. Technische Universität Dresden, International Institute Zittau, Markt 23, 02763, Zittau, Germany
62. University of Minnesota, Bell Museum, 1445 Gortner Avenue, 55108.0, St. Paul, USA
63. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Forest Dynamics, Zürcherstrasse 111, CH-8909, Birmensdorf, Switzerland
64. 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
65. University of Tartu, Institute of Ecology and Earth Sciences, Lai st 40, 51005, Tartu, Estonia

Abstract

Motivation: Assessing biodiversity status and trends in plant communities is critical for understanding, quantifying and predicting the effects of global change on ecosystems, among other applications. Vegetation plots record occurrence or abundance of all plant species present (community composition) in delimited local areas. These data also allow inferring absences, enabling many analyses not possible using the presence-only data provided by existing global plant datasets. Although very many vegetation plots have been recorded, most are not available to the global research community. A recent initiative, sPlot, compiled the first global vegetation plot database, and continues to grow and curate it. However, this large dataset is challenging to work with because it is extremely unbalanced spatially, and because the data are not open-access. Here, we address both these issues by (a) resampling the vegetation plots using a novel algorithm and (b) securing permission from data holders to openly release data (from 104 local to regional datasets). 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 truthing data in remote sensing applications or as a baseline for biodiversity monitoring.

Main types of variable contained: 95,104 vegetation plots, recording cover or abundance of naturally occurring vascular plant species in delimited areas. 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 mean and variance of 18 plant functional traits from the 'TRY' database.

Spatial location and grain: global, 0.01-40,000 m^2.

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, Big-data, Database, Functional traits, 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), including animals hosting pathogens transmissible to humans (6; 7). This has profound potential impacts on ecosystems and human health (8; 9).

Plant communities are no exception to this biodiversity crisis (10; 11; 5). This is particularly worrying since terrestrial vegetation accounts for 80% (450 Gt C) of the living biomass on Earth (12). Given the central role of vegetation in ecosystem productivity, structure, stability and functioning (11), 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 (13, 14). Large independent collections of plant occurrence data do exist at the global or continental extent via the Botanical Information and Ecology Network (BIEN) (15), the Global Inventory of Floras and Traits (GIFT) (16) or the Global Biodiversity Information Facility (GBIF) (https://www.gbif.org/). However, these databases are either imbalanced towards tree species only, or neglect how individual plant species co-occur and interact locally to form plant communities, or are collected at spatial resolutions which preclude intersection with high resolution remote sensing data and are too coarse (e.g., one-degree grid cells) to assess biodiversity trends at the plant community scale (17).

Yet, there is a long tradition among botanists to record the cover or abundance of each plant species that occurs in a vegetation plot location of a given size (i.e. surface area) at a given time (e.g. 18). Compared to presence-only data, vegetation-plot data (termed 'presence-absence' here) 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 (19). 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 (20). Being spatially explicit, vegetation plots can be resurveyed through time to assess potential changes in plant species composition relative to a baseline (21; 22, 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 (23, 24).

Globally, however, vegetation-plot data are very fragmented, as they typically stem from a myriad of local research and survey projects (25). Consequently, these data often have high fine-grain spatial resolutions but small spatial extents (26). Furthermore, with their disparate sampling protocols, standards and taxonomic resolutions, aggregating and harmonizing vegetation plot data proves extremely challenging (27). It is not surprising, therefore, that these data are rarely used in global-scale research on the biodiversity of plant communities (28; 29; 30).

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 (25). Established in 2013, sPlot (version 3) currently contains more than 1.9 million vegetation plots, and is fully integrated with the TRY database (31), from which it derives information on plant functional traits. The sPlot database is increasingly being used to study continental-to-global scale vegetation patterns, 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 (27).

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 94,210 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 this large dataset 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 (31).

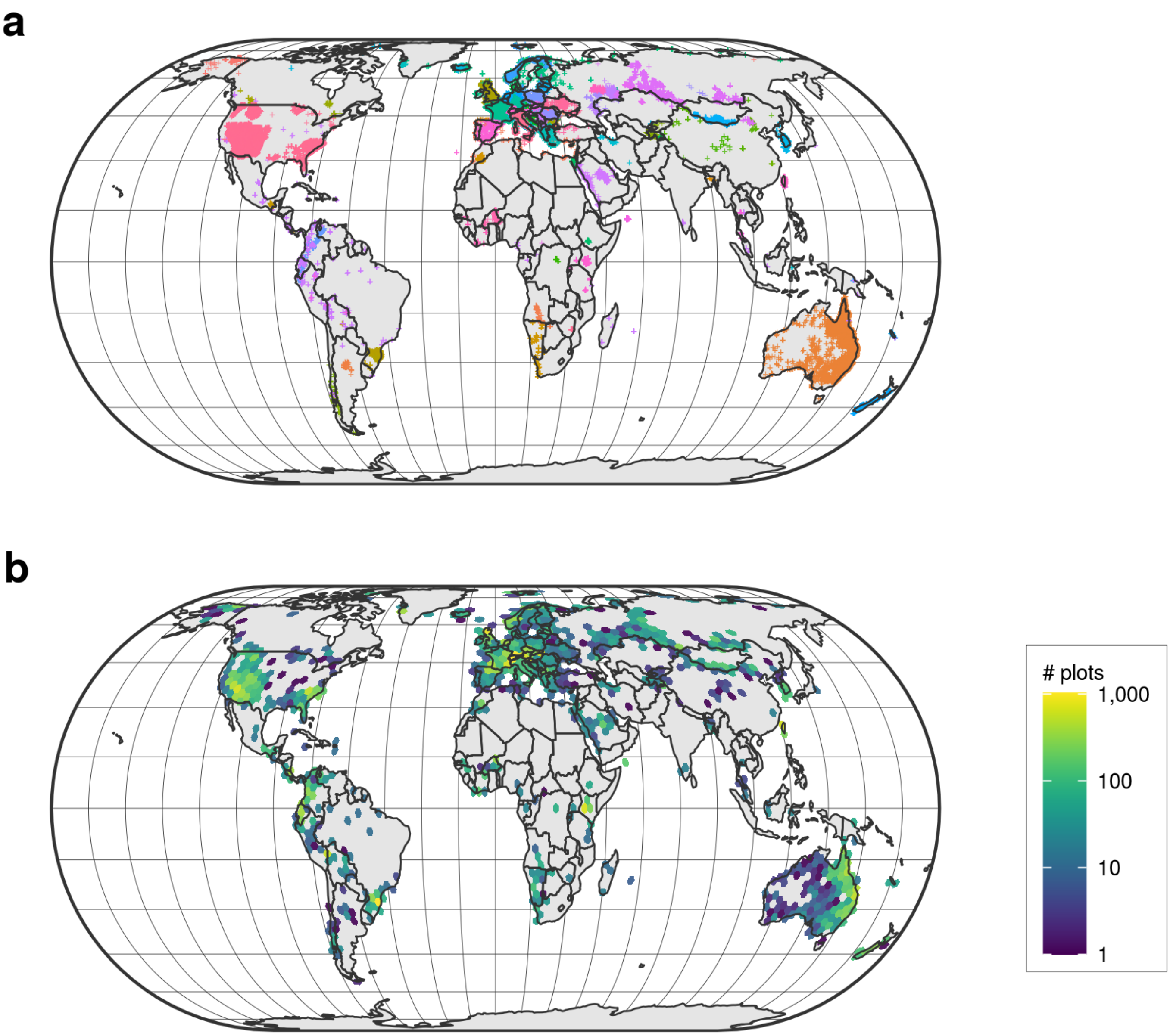

Figure 1: Top: Global distribution of all vegetation plots contained in sPlotOpen (n = 95,104). Each color represents a different source dataset (n = 105 - different datasets might have the same color). Bottom: Spatial distribution of vegetation plot density in the first resampling iteration (n = 49,787). Densities are calculated in hexagonal cells with a spatial resolution of approximately 70,000 km². 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 (also called 'relevés') and 23,586,216 species records. sPlot focuses on natural vegetation, i.e., plant cover that develops with little or no human interference. Data originate from 110 different vegetation-plot datasets of regional, national or continental extent, some of which stemming from regional or continental initiatives (see 25 for more information). For instance: 48 vegetation-plot datasets derive from the European Vegetation Archive (EVA) (19); 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 27). First, we removed vegetation plots without geographical coordinates or with a location uncertainty higher than 3 km. We also removed vegetation plots from wetlands and from 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 tried to reduce the geographical imbalance. 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. We considered 30 climatic and soil variables. For climate, we complemented the 19 bioclimatic variables from CHELSA v1.2 (39), as well as two 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: soil organic carbon content in the fine earth fraction, cation exchange capacity, pH, as well as the fractions of coarse fragments, sand, silt and clay.

We stratified our sampling effort based on the following procedure. First, we ran a global principal component analysis (PCA) on a matrix of terrestrial grid cells by the 30 above-mentioned environmental variables. We considered the full environmental space of all terrestrial habitats on Earth at a spatial resolution of 2.5 arcmin, totaling 8,384,404 terrestrial grid cells, irrespective of whether a grid cell hosted vegetation plots from the sPlot database v2.1 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. Atter projecting the 799,400 vegetation plots onto this PC1-PC2 grid, we calculated how many vegetation plots occurred in each PC1-PC2 grid cell (Figure 2). We then resampled those grid cells (n = 858) with more than 50 vegetation plots, which is the median of plots occurring across occupied grid cells. For each of these cells, we selected up to 50 vegetation plots using the heterogeneity-constrained random resampling algorithm from Lengyel et al. (2011) [42]. This approach optimizes the selection of a random subset of vegetation plots that encompasses the highest variability in species composition while avoiding peculiar and rare communities, which may represent outliers. 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 them according to the mean (ascending order) and variance (descending order) value. 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 sPlot database. We repeated the resampling procedure three times to get three different possibilities of a heterogeneity-constrained selection of 50 vegetation plots per PC1-PC2 grid cell with, initially, more than 50 vegetation plots. Vegetation plots selected during the first iteration were our first choice, while we considered the vegetation plots additionally selected in the second and third iteration as reserves when asking for permission to release the data as open access to each dataset's contributor(s).

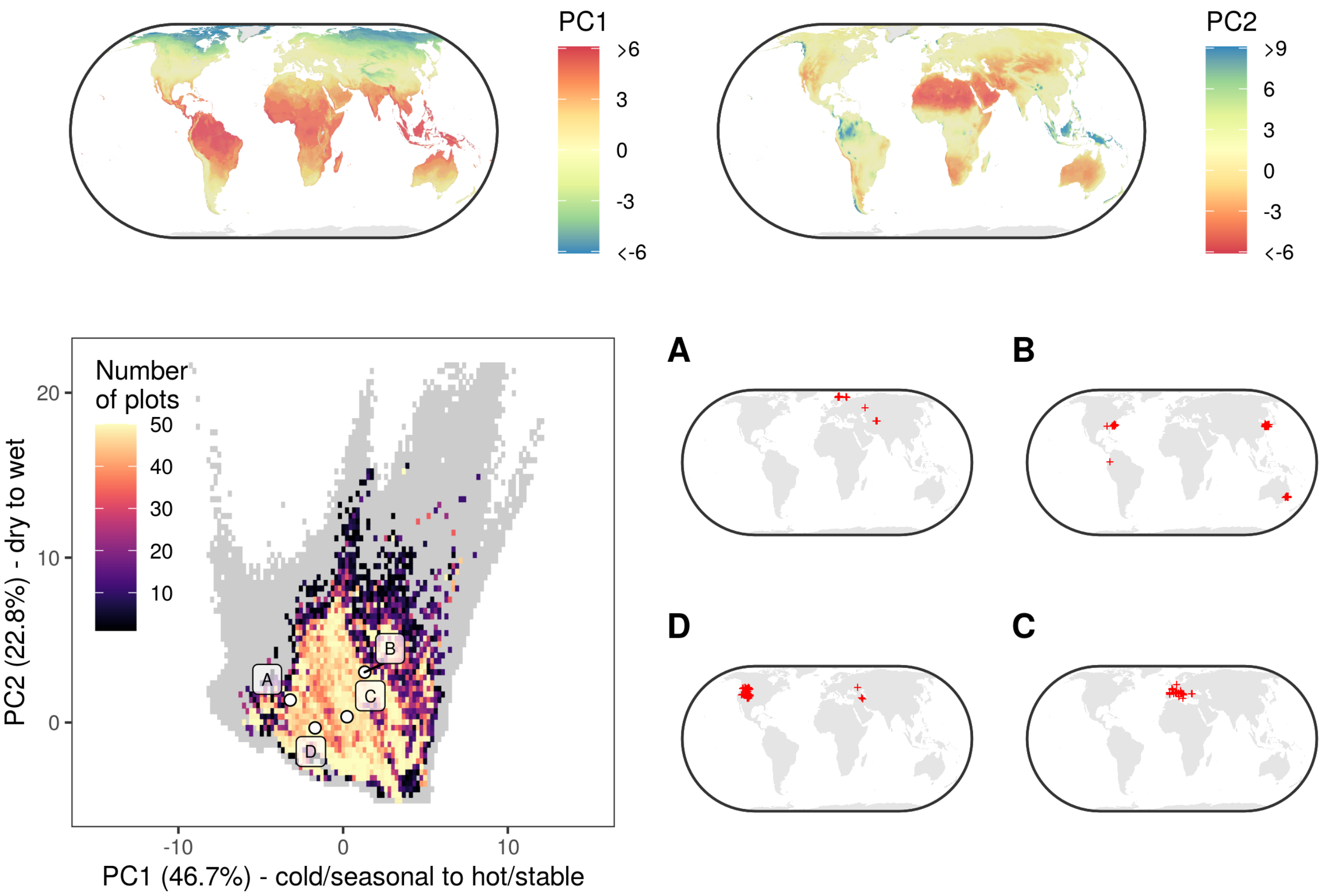

Figure 2: Distribution of vegetation plots from sPlotOpen in the global environmental space based on a principal component analysis (PCA) using 30 climate and soil variables. Top: Spatial distribution of PCA values across all terrestrial grid cells (n = 8,384,404, spatial grain = 2.5 arcmin). Bottom Left: Distribution of plots compared to the distribution of all terrestrial 2.5 arc-minute cells (gray background) in the PCA space. The PCA space was divided into a 100 × 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 a preliminary selection of 107,238 vegetation plots across the three resamplings. 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 each selected vegetation plot as open access. For 12,035 vegetation plots, permission could not be granted because, for instance, the data are unpublished, confidential or sensitive. Of these 6,625 were first choice plots, and were distributed across 770 PC1-PC2 grid cells (44.1% of occupied cells). For these vegetation plots, we used the reserve pool to randomly select replacements, for which such permission could be granted. 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. There were 3,150 plots that could not be replaced from the reserve pool. 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 (31). 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 (25). The eighteen plant functional traits (all concentrations based on dry weight) were: (1) leaf area [mm^2]; (2) stem specific density [$g\ cm^{-3}$]; (3) specific leaf area [$m^2 kg^{-1}$]; (4) leaf carbon concentration [$mg\ g^{-1}$]; (5) leaf nitrogen concentration [$mg\ g^{-1}$]; (6) leaf phosphorus concentration [$mg\ g^{-1}$]; (7) plant height [m]; (8) seed mass [mg]; (9) seed length [mm]; (10) leaf dry matter content [$g\ g^{-1}$]; (11) leaf nitrogen per area [$g\ m^{-2}$]; (12) leaf N:P ratio [$g\ g^{-1}$]; (13) leaf $\delta^{15}N$ [per million]; (14) seed number per reproductive unit; (15) leaf fresh mass [g]; (16) stem conduit density [mm^{-2}]; (17) dispersal unit length [mm]; and (18) conduit element length [μm].

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 (31). 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 priory assumptions, except for assuming that the data are 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 = 21,863). Additional information on the gap-filling procedure is available in [25].

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

$$CWM_{j,k} = \sum_{i}^{n_k} p_{i,k} t_{i,j} \tag{1}$$

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

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 vegetation plots from 114 countries and all continents except Antarctica (Figure 1). This randomized selection comes from 105 constitutive datasets (Table 1). The number of plots selected in each of the three resampling iterations is 49,787, 49,811 and 49,789. After replacing replacing confidential plots with reserves from the same PC grid cell, the first resampling iteration contains 53,262 plots. The number of plots shared across all the three iterations is 19,672, while 14,939 plots are shared between two iterations. 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 65,461 vegetation plots, and ranges between 0.03 and 40,000 m^2 (mean = 377 m^2; median = 100 m^2). Specifically, sPlotOpen contains 12,894 plots with size smaller than 10 m^2, 25,742 with size 10-100 m^2, 24,750 plots with size 100-1,000 m^2 and 2,075 plots with size greater or equal to 10,000 m^2. 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 environmental niche space. Yet, due to the lack or scarcity of data from some geographical regions, like the tropics, the spatial distribution of vegetation plots remains unbalanced 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, Europe is by far the best represented continent, with 15,920 vegetation plots. In contrast, in Africa and South America the remaining plots after data edition and selection were 3,709, and 5,498 vegetation plots, respectively. Compared to continents, the representation of biomes is better balanced. 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 these imbalances, 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 large global datasets that are available, such as GBIF.

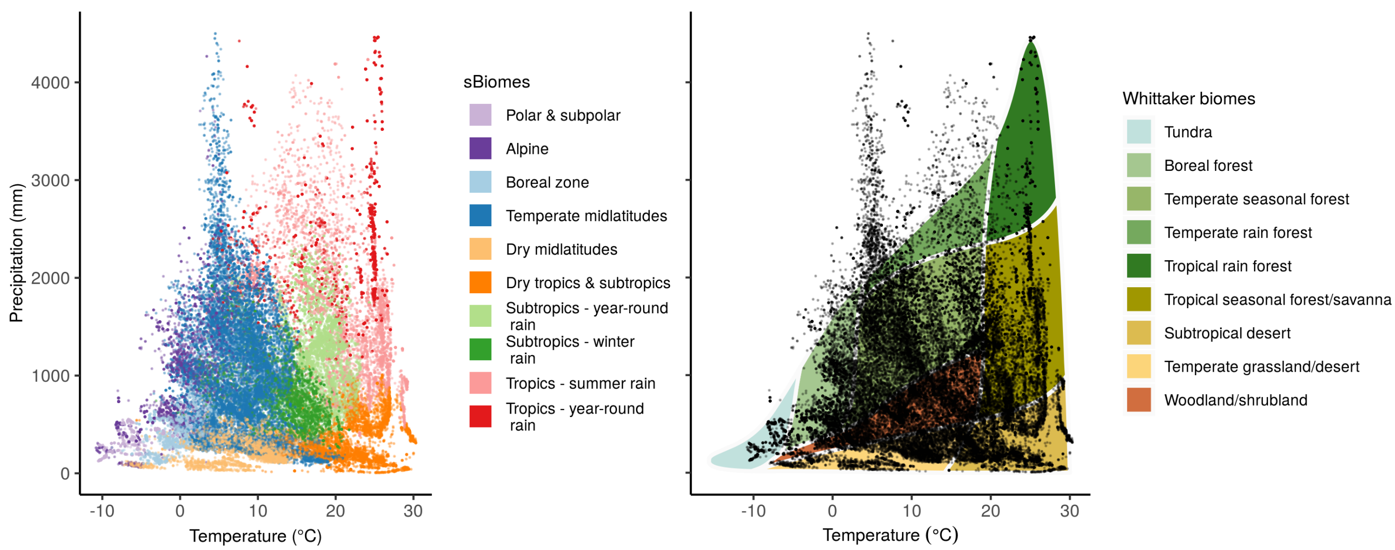

Figure 3: Distribution of vegetation plots in the first resampling iteration of sPlotOpen (n = 49,787) in the two-dimensional climatic space represented by mean annual temperature and mean annual precipitation. Left: plots are color coded based on sBiomes, i.e., sPlot's definition of biomes (25), which 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 vegetation plots in sPlotOpen belong to forest (n = 38,264), one half to non-forest vegetation (n = 45,753) vegetation, 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 (normalized to 100%), 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) [25]. 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, or to contact the custodians of each dataset before using sPlotOpen.

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 provided in sPlotOpen, 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 1,938,401 records from 42,677 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'*), together with its 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^2/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'* returns the number of species recorded in each plot. The columns *'Trait_coverage_cover'* and *'Trait_coverage_pa'* return, respectively, the proportion of total cover and species in a plot for which functional trait information was available. Functional trait information was available for 21,863 species. The average proportion of species in each plot for which we have functional trait information is 0.85 (median = 0.95). For 42,025 plots, the coverage is complete, while for only 482 plots do we have no functional trait information for any of the species occurring in it. When considering relative cover, the average trait coverage is 0.87. As many as 68,137 and 74,374 plots have functional trait information for 80% or more of the species or relative cover, respectively.

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 = 300), 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 and, if it was in a different format, we converted it to a Turboveg 2 dataset (54). 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 (31) to their resolved version based on the Taxonomic Name Resolution Service web application (TNRS version 4.0; 56; iPlant Collaborative, 2015). This allowed us to (1) harmonize all datasets to a common nomenclature, and (2) link the sPlot database to the TRY database (31). The final backone only retained matched taxonomic names at the rank of species or higher. Additional detail on the taxonomic resolution is reported in Bruelheide et al. (2019) [25], while a description of the workflow, including R-code, is available in Purschke (2017) [55].

Usage Notes

The sPlotOpen database can be downloaded from https://www.idiv.de (link to PlantHub). 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/sPlot).

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 (www.idiv.de/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/). 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).

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. Bönisch (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 recieved 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). 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 would like to acknowledge 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 Schrodt was supported by a University of Minnesota Institute on the Environment Discovery Grant, a German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig grant (50170649_#7) and a University of Nottingham Anne McLaren Fellowship. 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 acknowledge 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 the manuscript.

Competing interests

The authors declare no competing interests.

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 · PMID: 32879498

4. **Species better track climate warming in the oceans than on land**
   Jonathan Lenoir, Romain Bertrand, Lise Comte, Luana Bourgeaud, Tarek Hattab, Jérôme Murienne, Gaël Grenouillet
   Nature Ecology & Evolution (2020-05-25) https://doi.org/ggx3np
   DOI: 10.1038/s41559-020-1198-2 · PMID: 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 Hédl, 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 · PMID: 32284580

6. **Global trends in emerging infectious diseases**
   Kate E. Jones, Nikkita G. Patel, Marc A. Levy, Adam Storeygard, Deborah Balk, John L. Gittleman, Peter Daszak
   Nature (2008-02) https://doi.org/cbxh9h
   DOI: 10.1038/nature06536 · PMID: 18288193 · PMCID: PMC5960580

7. **Altitudinal Changes in Malaria Incidence in Highlands of Ethiopia and Colombia**
   A. S. Siraj, M. Santos-Vega, M. J. Bouma, D. Yadeta, D. R. Carrascal, M. Pascual
   Science (2014-03-06) https://doi.org/f5vb47
   DOI: 10.1126/science.1244325 · PMID: 24604201

8. **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 · PMID: 28360268

9. **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 · PMID: 28568902

10. **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 · PMID: 18583610

11. **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 · PMID: 21613148

12. **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 · PMID: 29784790 · PMCID: PMC6016768

13. **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

14. **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

15. **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/ghfnsx
DOI: 10.7287/peerj.preprints.2615v2

16. **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

17. **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 · PMID: 20532234 · PMCID: PMC2879389

18. **Versuch einer Übersicht über die Wiesentypen der Schweiz**
F. G. Stebler, C. Schröter

Landwirt. Jahrb. Schweiz (1893)

19. **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 Aćić, Emiliano Agrillo, … Sergey Yamalov
Applied Vegetation Science (2016-01) https://doi.org/bc7k
DOI: 10.1111/avsc.12191

20. **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 · PMID: 19323182

21. **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 · PMID: 29271579

22. **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 Bardy-Durchhalter, Elena Barni, … Sonja Wipf
Nature (2018-04-04) https://doi.org/gdfwk3
DOI: 10.1038/s41586-018-0005-6 · PMID: 29618821

23. **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

24. **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

25. **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

26. **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 · PMID: 30883539 · PMCID: PMC6445469

27. **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 · PMID: 30455437

28. **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

29. **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

30. **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

31. **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

32. **Global fern and lycophyte richness explained: How regional and local factors shape plot richness**
Anna Weigand, Stefan Abrahamczyk, Isabelle Aubin, Claudia Bita-Nicolae, Helge Bruelheide, Cesar I. Carvajal-Hernández, Daniele Cicuzza, Lucas Erickson Nascimento da Costa, János Csiky, Jürgen Dengler, … Michael Kessler
Journal of Biogeography (2020-01) https://doi.org/ggf4gr
DOI: 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 · PMID: 32063745 · PMCID: 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) https://www.routledgehandbooks.com/doi/10.1201/9781315368252
ISBN: 9781498751339

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

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

39. **Climatologies at high resolution for the earth's land surface areas**
Dirk Nikolaus Karger, Olaf Conrad, Jürgen Böhner, 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 · PMID: 28872642 · PMCID: 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
DOI: 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 · PMID: 28207752 · PMCID: PMC5313206

42. **Heterogeneity-constrained random resampling of phytosociological databases**
Attila Lengyel, Milan Chytrý, Lubomír Tichý
Journal of Vegetation Science (2011-02) https://doi.org/dvjzbz
DOI: 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

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

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

46. **Uncertainty Quantified Matrix Completion Using Bayesian Hierarchical Matrix Factorization**
Farideh Fazayeli, Arindam Banerjee, Jens Kattge, Franziska Schrodt, Peter B. Reich
Institute of Electrical and Electronics Engineers (IEEE) (2014-12) https://doi.org/ghfnw3
DOI: 10.1109/icmla.2014.56

47. **BHPMF - a hierarchical Bayesian approach to gap-filling and trait prediction for macroecology and functional biogeography**
Franziska Schrodt, 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

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

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

50. **A global inventory of mountains for bio-geographical applications**
Christian Körner, Walter Jetz, Jens Paulsen, Davnah Payne, Katrin Rudmann-Maurer, Eva M. Spehn
Alpine Botany (2016-12-19) https://doi.org/f93fmr
DOI: 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

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

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

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

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 · PMID: 23324024 · PMCID: 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 · PMID: 31233491 · PMCID: 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

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

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

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

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

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

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 · PMID: 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

68. **Vegetation Database of Southern Morocco**
Manfred Finckh
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgvcq
DOI: 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

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

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

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/gbkd6v
DOI: 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

75. **Vegetation Database of Sinai in Egypt**
Mohamed Hatim
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgvcr
DOI: 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

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

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

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

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 · PMID: 28149178 · PMCID: 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

82. **Socotra Vegetation Database**
Michele De Sanctis, Fabio Attorre
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgvct
DOI: 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

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

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

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

88. **Balkan Dry Grasslands Database**
Kiril Vassilev, Zora Dajiś, Renata Cušterevska, Erwin Bergmeier, Iva Apostolova
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgvcw
DOI: 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

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 · PMID: 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

92. **WetVegEurope: a database of aquatic and wetland vegetation of Europe**
Flavia Landucci, Marcela Řezníčková, Kateřina Šumberová, Milan Chytrý, Liene Aunina, Claudia Biţă-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

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

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

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

96. **Bulgarian Vegetation Database: historic background, current status and future prospects**
Iva Apostolova, Desislava Sopotlieva, Hristo Pedashenko, Nikolay Velev, Kiril Vasilev
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgvch
DOI: 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

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

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

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

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

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

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

105. **Phytosociological Database of Non-Forest Vegetation in Croatia**
Zvjezdana Stancic
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgt9f
DOI: 10.7809/b-e.00180

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

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

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

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

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 Kącki, Michał Śliwiński
Acta Societatis Botanicorum Poloniae (2012) https://doi.org/f34f3k
DOI: 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

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 Csergő, Iliana Dzhovanova, Eva Filipova, József Pál Frink, … Jürgen Dengler
Phytocoenologia (2018-03-01) https://doi.org/gc79hp
DOI: 10.1127/phyto/2017/0229

115. **Vegetation Database Grassland Vegetation of Serbia**
Svetlana Aćić, Milicia Petrović, Urban Šilc, Zora Dajić Stevanović
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgt9h
DOI: 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

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

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

119. **Vegetation Database of Slovenia**
Urban Šilc
Biodiversity & Ecology (2012-09-10) https://doi.org/ghgt9k
DOI: 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

121. **Ukrainian Grasslands Database**
Anna Kuzemko
Biodiversity & Ecology (2012-09-10) https://doi.org/ghk7f3
DOI: 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

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

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

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

128. **The Alaska Arctic Vegetation Archive (AVA-AK)**
Donald A. Walker, Amy L. Breen, Lisa A. Druckenmiller, Lisa W. Wirth, Will Fisher, Martha K. Raynolds, 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

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

130. **The Floristic and Forest Inventory of Santa Catarina State (IFFSC): methodological and operational aspects**
A. C. Vibrans, L. Sevegnani, D. V. Lingner, A. L. Gasper, S. Sabbagh
Pesquisa Florestal Brasileira (2010)

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

Supplementary Material

Table 1: List of databases contributing sPlotOpen, the open access dataset extracted from the sPlot database. Databases are ordered based on their ID in the Global Index of Vegetation Databases (GVID ID).

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
00-00-001	ForestPlots.net	Oliver L. Phillips	Aurora Levesley	169	59
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	60
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	61
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	62
AF-00-003	BIOTA Southern Africa Biodiversity Observatories Vegetation Database	Norbert Jürgens	Ute Schmiedel	1015	63
AF-00-006	SWEA-Dataveg	Miguel Alvarez	Michael Curran	1675	
AF-00-008	PANAF Vegetation Database	Hjalmar Kühl	TeneKwetche Sop	884	
AF-00-009	Vegetation Database of the Okavango Basin	Rasmus Revermann	Manfred Finckh	378	64
AF-BF-001	Sahel Vegetation Database	Jonas V. Müller	Marco Schmidt	556	65
AF-CD-001	Forest Database of Central Congo Basin	Kim Sarah Jacobsen	Hans Verbeeck	140	66
AF-ET-001	Vegetation Database of Ethiopia	Desalegn Wana	Anke Jentsch	67	67
AF-MA-001	Vegetation Database of Southern Morocco	Manfred Finckh		621	68
AF-ZW-001	Vegetation Database of Zimbabwe	Cyrus Samimi		31	69
AS-00-001	Korean Forest Database	Tomáš Černý	Jiri Dolezal	1039	70
AS-00-003	Vegetation of Middle Asia	Arkadiusz Nowak	Marcin Nobis	314	71
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	72
AS-CN-002	Tibet-PaDeMoS Grazing Transect	Karsten Wesche		58	73
AS-CN-003	Vegetation Database of the BEF China Project	Helge Bruelheide		24	74

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
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	75
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	76
AS-MN-001	Southern Gobi Protected Areas Database	Henrik von Wehrden	Karsten Wesche	1032	77
AS-RU-001	Wetland Vegetation Database of Baikal Siberia (WETBS)	Victor Chepinoga		9	78
AS-RU-002	Database of Siberian Vegetation (DSV)	Andrey Korolyuk	Andrei Zverev	3634	79
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	80
AS-TJ-001	Eastern Pamirs	Kim André Vanselow		221	81
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	82
AU-AU-002	AEKOS	Ben Sparrow		10976	36
AU-NC-001	New Caledonian Plant Inventory and Permanent Plot Network (NC-PIPPN)	Jérôme Munzinger	Philippe Birnbaum	98	83
AU-NZ-001	New Zealand National Vegetation Databank	Susan K. Wiser		1127	84
AU-PG-001	Forest Plots from Papua New Guinea	Timothy J.S. Whitfeld	George D. Weiblen	60	85
EU-00-002	Nordic-Baltic Grassland Vegetation Database (NBGVD)	Jürgen Dengler	Łukasz Kozub	54	86
EU-00-011	Vegetation-Plot Database of the University of the Basque Country (BIOVEG)	Idoia Biurrun	Itziar García-Mijangos	2142	87
EU-00-013	Balkan Dry Grasslands Database	Kiril Vassilev	Armin Macanović	269	88
EU-00-016	Mediterranean Ammophiletea Database	Corrado Marcenò	Borja Jiménez-Alfaro	783	89
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	90

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
EU-00-019	Balkan Vegetation Database	Kiril Vassilev	Hristo Pedashenko	484	91
EU-00-020	WetVegEurope	Flavia Landucci		127	92
EU-00-022	European Mire Vegetation Database	Tomáš Peterka	Martin Jiroušek	2560	93
EU-AL-001	Vegetation Database of Albania	Michele De Sanctis	Giuliano Fanelli	31	94
EU-AT-001	Austrian Vegetation Database	Wolfgang Willner	Christian Berg	2310	95
EU-BE-002	INBOVEG	Els De Bie		119	
EU-BG-001	Bulgarian Vegetation Database	Iva Apostolova	Desislava Sopotlieva	160	96
EU-CH-005	Swiss Forest Vegetation Database	Thomas Wohlgemuth		2134	97
EU-CZ-001	Czech National Phytosociological Database	Milan Chytrý	Ilona Knollová	1287	98
EU-DE-001	VegMV	Florian Jansen	Christian Berg	15	99
EU-DE-013	VegetWeb Germany	Florian Jansen	Jörg Ewald	587	100
EU-DE-014	German Vegetation Reference Database (GVRD)	Ute Jandt	Helge Bruelheide	762	101
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	102
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	103
EU-GR-006	Hellenic Woodland Database	Ioannis Tsiripidis	Georgios Fotiadis	17	104
EU-HR-001	Phytosociological Database of Non-Forest Vegetation in Croatia	Zvjezdana Stančić		193	105
EU-HR-002	Croatian Vegetation Database	Željko Škvorc	Daniel Krstonošić	585	
EU-HU-003	CoenoDat Hungarian Phytosociological Database	János Csiky	Zoltán Botta-Dukát	46	106
EU-IT-001	VegItaly	Roberto Venanzoni	Flavia Landucci	754	107
EU-IT-010	Vegetation database of Habitats in the Italian Alps – HabItAlp	Laura Casella	Pierangela Angelini	247	108
EU-IT-011	Vegetation-Plot Database Sapienza University of Rome (VPD-Sapienza)	Emiliano Agrillo	Fabio Attorre	967	109
EU-LT-001	Lithuanian Vegetation Database	Valerijus Rašomavičius	Domas Uogintas	81	

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. open-access plots	Ref
EU-LV-001	Semi-natural Grassland Vegetation Database of Latvia	Solvita Rūsiņa		369	110
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	111
EU-PL-001	Polish Vegetation Database	Zygmunt Kącki	Grzegorz Swacha	692	112
EU-RO-007	Romanian Forest Database	Adrian Indreica	Pavel Dan Turtureanu	166	113
EU-RO-008	Romanian Grassland Database	Eszter Ruprecht	Kiril Vassilev	82	114
EU-RS-002	Vegetation Database Grassland Vegetation of Serbia	Svetlana Aćić	Zora Dajić Stevanović	217	115
EU-RU-002	Lower Volga Valley Phytosociological Database	Valentin Golub	Andrey Chuvashov	383	116
EU-RU-003	Vegetation Database of the Volga and the Ural Rivers Basins	Tatiana Lysenko		174	117
EU-RU-011	Vegetation Database of Tatarstan	Vadim Prokhorov	Maria Kozhevnikova	206	118
EU-SI-001	Vegetation Database of Slovenia	Urban Šilc	Filip Küzmič	1029	119
EU-SK-001	Slovak Vegetation Database	Milan Valachovič	Jozef Šibík	2394	120
EU-UA-001	Ukrainian Grasslands Database	Anna Kuzemko	Yulia Vashenyak	301	121
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		231	122
NA-CA-003	Database of Timberline Vegetation in NW North America	Viktoria Wagner	Toby Spribille	63	123
NA-CA-004	Understory of Sugar Maple Dominated Stands in Quebec and Ontario (Canada)	Isabelle Aubin		13	124
NA-CA-005	Boreal Forest of Canada	Yves Bergeron	Louis De Grandpré	57	
NA-GL-001	Vegetation Database of Greenland	Birgit Jedrzejek	Fred J.A. Daniëls	441	125
NA-US-002	VegBank	Robert K. Peet	Michael T. Lee	14965	126
NA-US-006	Carolina Vegetation Survey Database	Robert K. Peet	Michael T. Lee	3263	127
NA-US-014	Alaska-Arctic Vegetation Archive	Donald A. Walker	Amy Breen	771	128
SA-00-002	VegPáramo	Gwendolyn Peyre	Xavier Font	2010	129
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	130

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	131
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 is in Bruelheide et al. (2019) [25]. 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. non-NA Records	Type
GIVD_ID			95094	n
Dataset			95094	n
Continent	Africa, Asia, Europe, North America, Oceania, South America		95094	n
Country			95094	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		95094	n
Date_of_recording	1888-07-05 - 2015-02-03	dd-mm-yyyy	80075	d
Latitude	-54.82303 - 80.149116	° (WGS84)	95094	q
Longitude	-162.741433 - 176.4221	° (WGS84)	95094	q
Location_uncertainty	1 - 2750	m	95065	q
Releve_area	0.03 - 40000	m^2	65451	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		95094	n
Elevation	-30 - 5960	m a.s.l.	62968	q
Aspect	1 - 360	°	42178	q
Slope	0 - 90	°	51246	q
is_forest	FALSE = 45753; TRUE = 38254		84007	b

Variable	Range/Levels	Unit of Measurement	Nr. non-NA Records	Type
ESY			39632	n
Naturalness	1 = Natural, 2 = Semi-natural		60182	o
Forest	FALSE = 36282; TRUE = 33160		69442	b
Shrubland	FALSE = 58235; TRUE = 11207		69442	b
Grassland	FALSE = 33790; TRUE = 35652		69442	b
Wetland	FALSE = 59186; TRUE = 10256		69442	b
Sparse_vegetation	FALSE = 66167; TRUE = 3275		69442	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		95094	q
SoilClim_PC2	-4.824 - 15.466		95094	q
Resample_1	FALSE = 45314; TRUE = 49780		95094	b
Resample_2	FALSE = 45292; TRUE = 49802		95094	b
Resample_3	FALSE = 45313; TRUE = 49781		95094	b
Resample_1_consensus	FALSE = 41835; TRUE = 53259		95094	b

Supplementary Material

Figure S1

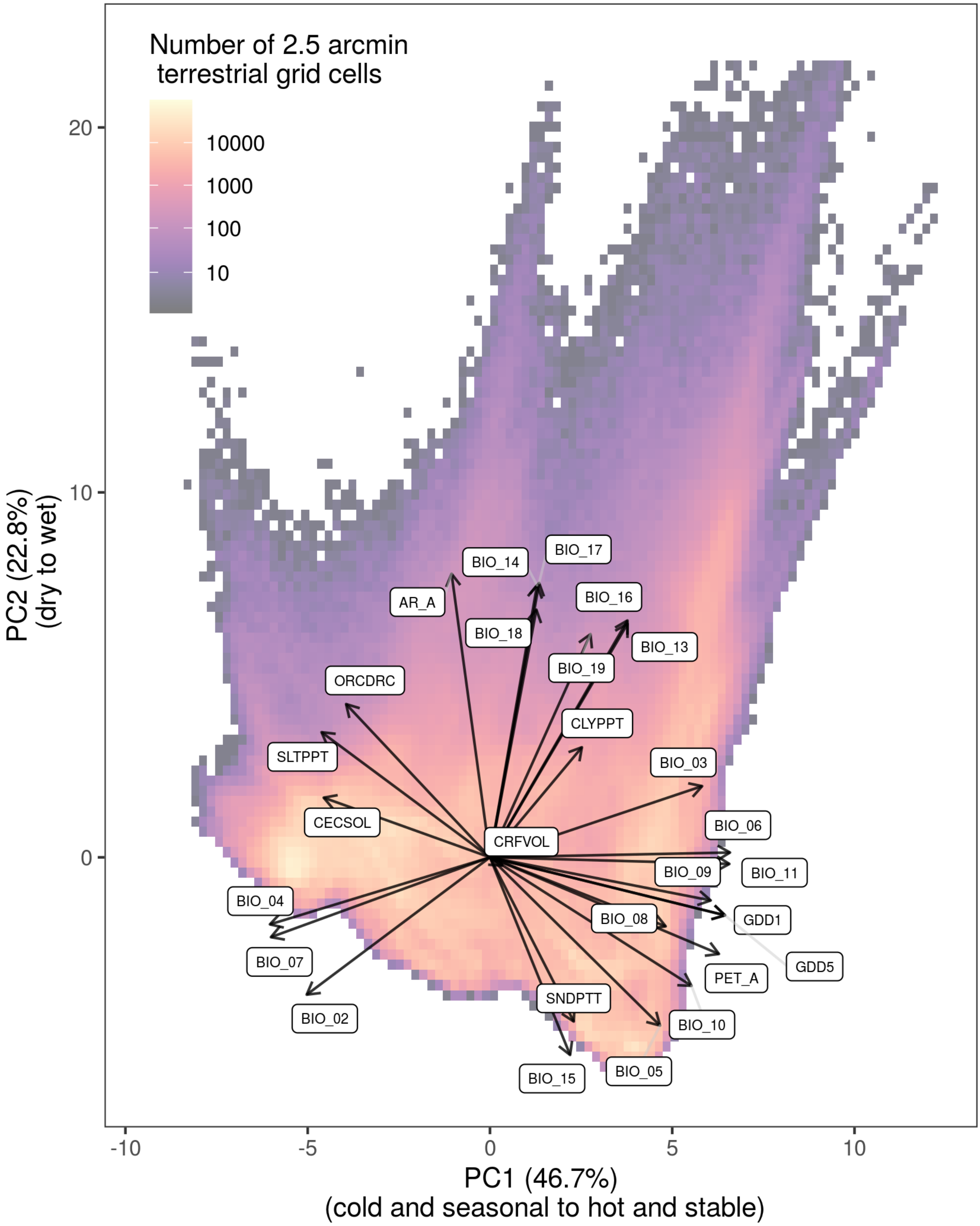

Figure S1: Global principal component analysis (PCA) of the world environmental conditions. The PCA is based on the matrix of all terrestrial grid cells (n = 8,384,404, spatial grain = 2.5 arcmin) by 30 environmental variables. The PCA space represents the full environmental space of all terrestrial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