

sPlot open - An environmentally-balanced, open-access, global dataset of vegetation plots

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Authors

✉ Francesco Maria Sabatini^{1,2,†}, Jonathan Lenoir^{3,†}, Tarek Hattab⁴, Elise Arnst⁵, Milan Chytrý⁶, Jürgen Dengler^{7,8,9}, Valério De Patta Pillar¹⁰, Patrice De Ruffray¹¹, Stephan M. Hennekens¹², Ute Jandt², Florian Jansen¹³, Borja Jiménez-Alfaro¹⁴, Jens Kattge¹⁵, Aurora Levesley¹⁶, Oliver Purschke¹⁷, Brody Sandel¹⁸, Fahmida Sultana¹⁹, Tsipe Aavik²⁰, Svetlana Aćić²¹, Alicia Acosta²², Emiliano Agrillo²³, Miguel Alvarez²⁴, Iva Apostolova²⁵, Mohammed A.S. Arfin Khan²⁶, Fabio Attorre²³, Isabelle Aubin²⁷, Marijn Bauters^{28,29}, Yves Bergeron³⁰, Erwin Bergmeier³¹, Idoia Biurrun³², Anne D. Bjorkman³³, Gianmaria Bonari³⁴, Viktoria Bondareva³⁵, Jörg Brunet³⁶, Andraž Carni³⁷, Laura Casella³⁸, Luis Cayuela³⁹, Tomáš Černý⁴⁰, Victor Chepinoga⁴¹, János Csiky⁴², Renata Čušterevska⁴³, Els De Bie⁴⁴, Michele De Sanctis²³, Panayotis Dimopoulos⁴⁵, Jiri Dolezal⁴⁶, Tetiana Dziuba⁴⁷, Mohamed Abd El-Rouf Mousa El-Sheikh^{48,49}, Brian Enquist⁵⁰, Jörg Ewald⁵¹, Richard Field⁵², Manfred Finckh⁵³, Antonio Galán-de-Mera^{54,55,56}, Emmanuel Garbolino⁵⁷, André Luis de Gasper⁵⁸, Hamid Gholizadeh⁵⁹, Melisa Giorgis⁶⁰, Valentin Golub⁶¹, Inger Greve Alsos⁶², John-Arvid Grytnes⁶³, Alvaro G. Gutierrez⁶⁴, Mohamed Z. Hatim^{65,66}, Bruno Herault⁶⁷, Guillermo Hinojos Mendoza⁶⁸, Norbert Hölzel⁶⁹, Jürgen Homeier⁷⁰, Wannes Hubau^{71,72}, Adrian Indreica⁷³, John Janssen¹², Birgit Jedrzejek⁷⁴, Anke Jentsch⁷⁵, Norbert Jürgens⁵³, Zygmunt Kącki⁷⁶, Jutta Kapfer⁷⁷, Ali Kavgacı⁷⁸, Elizabeth Kearsley⁷⁹, Michael Kessler⁸⁰, Larisa Khanina⁸¹, Andrey Korolyuk⁸², Holger Kreft⁸³, Hjalmar Kühl^{9,84}, Anna Kuzemko⁸⁵, Flavia Landucci⁸⁶, Hongyan Liu⁸⁷, Tatiana Lysenko⁸⁸, Miguel D. Mahecha⁸⁹, Corrado Marcenò³², Jesper Erenskjold Moeslund⁹⁰, Ladislav Mucina⁹¹, Jonas V. Müller⁹², Jérôme Munzinger⁹³, Jalil Noroozi⁹⁴, Arkadiusz Nowak⁹⁵, Viktor Onyshchenko⁹⁶, Gerhard E. Overbeck⁹⁷, Aníbal Pauchard^{98,99}, Robert K. Peet¹⁰⁰, Aaron Pérez-Haase^{101,102}, Tomáš Peterka⁸⁶, Gwendolyn Peyre¹⁰³, Oliver L. Phillips¹⁶, Vadim Prokhorov¹⁰⁴, Valerijus Rašomavičius¹⁰⁵, Rasmus Revermann⁵³, Gonzalo Rivas-Torres¹⁰⁶, John S. Rodwell¹⁰⁷, Eszter Ruprecht¹⁰⁸, Solvita Rūsiņa¹⁰⁹, Cyrus Samimi¹¹⁰, Marco Schmidt¹¹¹, Franziska Schrodtt¹¹², Jozef Šibík¹¹³, Urban Šilc¹¹⁴, Petr Sklenář¹¹⁵, Željko Škvorc¹¹⁶, Anita Smyth¹¹⁷, Ben Sparrow¹¹⁷, Marta Gaia Sperandii^{118,119}, Zvezdana Stančić¹²⁰, Jens-Christian Svenning¹²¹, Zhiyao Tang⁸⁷, Cindy Q. Tang¹²², Ioannis Tsiripidis¹²³, Milan Valachovič¹¹³, Kim André Vanselow¹²⁴, Kiril Vassilev²⁵, Eduardo Vélez-Martin¹²⁵, Roberto Venanzoni¹²⁶, Alexander Christian Vibrans¹²⁷, Cyrille Violle¹²⁸, Risto Virtanen^{9,129,130}, Henrik von Wehrden¹³¹, Viktoria Wagner¹³², Donald A. Walker¹³³, Desalegn Wana¹³⁴, Hua-Feng Wang¹³⁵, Karsten Wesche^{9,136,137}, Timothy Whitfeld¹³⁸, Wolfgang Willner¹³⁹, Susan Wiser⁵, Thomas Wohlgemuth¹⁴⁰, Sergey Yamalov¹⁴¹, Martin Zobel¹⁴², Helge Bruehlheide^{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. Germany
2. Martin-Luther University Halle-Wittenberg, Institute of Biology, Am Kirchtor 1, 06108, Halle, Germany
3. Unité de Recherche "Ecologie et Dynamique des Systèmes Anthropisés" (EDYSAN), UMR 7058 CNRS, Université de Picardie Jules Verne, 80037 Amiens Cedex 1, 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, Faculty of Science, 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. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103, Leipzig, Germany
10. Federal University of Rio Grande do Sul, Ecology, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, Brazil
11. IBMP, 12, rue du Général-Zimmer, 67084, Strasburg, France
12. Wageningen University and Research, Wageningen Environmental Research (Alterra), P.O.Box 47, 6700 AA, Wageningen, Netherlands
13. University of Rostock, Faculty of Agricultural and Environmental Sciences, Justus-von-Liebig-Weg 6, 18059, Rostock, Germany
14. University of Oviedo, Research Unit of Biodiversity (CSIC/UO/PA), C. Gonzalo Gutiérrez Quirós s/n, 33600, Mieres, Spain
15. Max Planck Institute for Biogeochemistry, Hans Knöll Str. 10, 07745, Jena, Germany
16. University of Leeds, School of Geography, Woodhouse Lane, LS2 9JT, Leeds, United Kingdom
17. 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
18. Aarhus University, Aarhus, Denmark
19. Shahjalal University of Science & Technology, Forestry & Environmental Science, 3114, Sylhet, Bangladesh
20. University of Tartu, Department of Ecology and Earth Sciences, Department of Botany, Lai 40, Tartu 51005, Estonia
21. Faculty of Agriculture, Department of Agrobotany, Nemanjina 6, 11080, Belgrade-Zemun, Serbia
22. Roma Tre University, Department of Sciences, V.le Marconi 446, 00146, Rome, Italy
23. Sapienza University of Rome, Department of Environmental Biology, P.le Aldo Moro 5, 00185, Rome, Italy
24. University of Bonn, Plant Nutrition, INRES, Karlrobert-Kreiten-Str., 53115, Bonn, Germany
25. 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
26. Shahjalal University of Science & Technology, Forestry & Environmental Science, Akhalia, 3114, Sylhet, Bangladesh
27. Canadian Forest Service, Natural Resources Canada, Great Lakes Forestry Centre, 1219 Queen St. East, P6A 2E5, Sault Ste Marie (Ontario), Canada
28. Ghent University, Department Green chemistry and technology, Isotope Bioscience laboratory (UGent-ISOFYS), Coupure Links 653, 9000, Ghent, Belgium
29. Ghent University, Department Environment, Computational and Applied Vegetation Ecology (UGent-CAVELab), Coupure Links 653, 9000, Ghent, Belgium
30. Université du Québec en Abitibi-Témiscamingue, Forest Research Institute, 445 boul. de l'Université, J9X5E4, Rouyn-Noranda, Canada
31. University of Göttingen, Vegetation Ecology and Phytodiversity, Untere Karspüle 2, 37073, Göttingen, Germany
32. University of the Basque Country UPV/EHU, Plant Biology and Ecology, P.O. Box 644, 48080, Bilbao, Spain
33. Aarhus University, Section for Ecoinformatics & Biodiversity, Department of Bioscience, Ny Munkegade 114, 8000, Aarhus C, Denmark
34. Free University of Bozen-Bolzano, Piazza Università, 5, 39100, Bolzano, Italy
35. Institute of Ecology of the Volga River Basin, Department of Phytodiversity Problems, Komzina, 10, 445003, Toljatty, Russia
36. Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Sundsvägen 3, 230 53 Alnarp, Sweden
37. Research Center of the Slovenian Academy of Sciences and Arts, Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenija
38. ISPRA - Italian National Institute for Environmental Protection and Research, Biodiversity Conservation Department, Via Vitaliano Brancati, 60, 00144, Roma, Italy
39. Universidad Rey Juan Carlos, Department of Biology, Geology, Physics and Inorganic Chemistry, c/ Tulipán s/n, 28933, Móstoles, Spain
40. Czech University of Life Sciences Prague, Department of Forest Ecology, Faculty of Forestry and Wood Sciences, Kamýcká 1176, 165 21, Praha 6 - Suchbát, Czech Republic
41. V.B. Sochava Institute of Geography SB RAS, Laboratory of Physical Geography and Biogeography, Ulan-Batorskaya, 1, 664033, Irkutsk, Russian Federation
42. University of Pécs, Department of Ecology, Ifjúság u. 6., 7624, Pécs, Hungary
43. Faculty of Natural Sciences and Mathematics, Institute of Biology, Arhimedova 3, 1000, Skopje, Republic of Macedonia
44. Research Institute for Nature and Forest (INBO), Department of Biodiversity and Natural Environment, Havenlaan 88, bus 73, 1000, Brussels, Belgium
45. University of Patras, Institute of Botany, Division of Plant Biology, Department of Biology, University Campus, 26504, Patras, Greece
46. Institute of Botany, Czech Academy of Sciences, Department of Functional Ecology, Dukelska 135, 37901, Trebon, Czech Republic
47. M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Geobotany and ecology, Tereshchenkivska, 1004, Kyiv, Ukraine

48. College of Science, King Saud University, Botany and Microbiology Department, P.O. Box 2455, 11451, Riyadh, Saudi Arabia
49. Damanhour University, Botany Department, Faculty of Science, Damanhour, Egypt
50. University of Arizona, Ecology and Evolutionary Biology, 1041 E. Lowell St., AZ 85721, Tucson, United States
51. Hochschule Weihenstephan-Triesdorf, University of Applied Sciences, Hans-Carl-von-Carlowitz-Platz 3, 85354, Freising, Germany
52. University of Nottingham, School of Geography, University Park, NG7 2RD, Nottingham, United Kingdom
53. University of Hamburg, Biodiversity, Ecology and Evolution of Plants, Institute for Plant Science & Microbiology, Ohnhorststr. 18, 22609, Hamburg, Germany
54. Universidad CEU San Pablo, Laboratorio de Botánica, P.O. Box 67, 28660, Boadilla del Monte, Madrid, Spain
55. Universidad Privada Antonio Guillermo Urrelo, Laboratorio de Botánica, Jr. José Sabogal
56. Estudios Fitogeográficos del Perú, Herbario AQP, Sánchez Cerro 219, Manuel Prado, Paucarpata, Arequipa, Peru
57. Climact Data Science (CDS), Nova Sophia - Regus Nova, 291 rue Albert Caquot, CS 40095, 06902, Sophia Antipolis Cedex, France
58. Regional University of Blumenau, Departament of Natural Science, Antonio da Veiga, 140, 89030-903, Blumenau, Brazil
59. University of Mazandaran, Department of Biology, Babolsar, Iran
60. Instituto Multidisciplinario de Biología Vegetal (IMBIV-CONICET), ECOLOGÍA VEGETAL Y FITOGEOGRAFÍA, Av. Vélez Sársfield 1611, 5000, Córdoba, Argentina
61. Institute of Ecology of the Volga River Basin, Laboratory of Phytocoenology, Komzina, 10, 445003, Toljatty, Russia
62. The Arctic University Museum of Norway, UiT - The Arctic University of Norway, Tromsø, Norway
63. University of Bergen, Department of Biological Sciences, Postbox 7803
64. Universidad de Chile, Departamento de Ciencias Ambientales y Recursos Naturales Renovables, Facultad de Ciencias Agronomicas, Santa Rosa 11315, La Pintana, 8820808, Santiago, Chile
65. Wageningen University, Plant Ecology and Nature Conservation Group - Environmental Sciences Department, P.O. Box Postbus 47, Droevendaalsesteeg 3, 6700 AA, Wageningen, The Netherlands
66. Tanta University, Botany and Microbiology Department - Faculty of Science, El Geish St., 31527, Tanta, Egypt
67. University of Montpellier, CIRAD, Forêts et Sociétés, Montpellier, France
68. ASES Ecological and Sustainable Services, Pépinière d'Entreprises l'Espéridou, Parc d'Activités du Vinobre, 555 Chemin des Traverses, Lachapelle-sous-Aubenas, 07200, Aubenas, France
69. University of Muenster, Institute of Landscape Ecology, Heisenbergstr. 2, 48149, Münster, Germany
70. University of Göttingen, Plant Ecology and Ecosystems Research, Untere Karspüle 2, 37073, Göttingen, Germany
71. Ghent University, Department Environment, Laboratory of Wood Biology (UGent-WoodLab), Coupure Links 653, 9000, Ghent, Belgium
72. Royal Museum for Central Africa, Service of Wood Biology, Leuvensesteenweg 13, 3080, Tervuren, Belgium
73. Transilvania University of Brasov, Department of Silviculture, Sirul Beethoven 1, 500123, Brasov, Romania
74. University of Münster, Institute of Landscape Ecology, Heisenbergstr. 2, 48149, Münster, Germany
75. University of Bayreuth, Department of Disturbance Ecology, Universitätsstr. 30, 95447, Bayreuth, Germany
76. University of Wrocław, Botanical Garden, Sienkiewicza 23, 50-335, Wrocław, Poland
77. Norwegian Institute of Bioeconomy Research, Holtvegen, 66, Tromsø, 9016, Norway
78. Southwest Anatolia Forest Research Institute, Silviculture and Forest Botany, POB 264, 07002, Antalya, Turkey
79. Ghent University, Department Environment, Computational and Applied Vegetation Ecology (UGent-CAVELab), Coupure Links 653, 9000, Gent, Belgium
80. University of Zurich, Department of Systematic and Evolutionary Botany, Zollikerstrasse 107, 8008, Zurich, Switzerland
81. Institute of Mathematical Problems of Biology of Russian Academy of Sciences, Laboratory of Computational Ecology, Prof. Vitkevicha str., 142290, Pushchino, Russia
82. Central Siberian Botanical Garden, Siberian Branch, Russian Academy of Sciences, Geosystem Laboratory, Zolotodolinskaya str. 101, 630090, Novosibirsk, Russian Federation
83. University of Göttingen, Department of Biodiversity, Macroecology and Biogeography, Büsgenweg 1, 37077, Göttingen, Germany
84. Max Planck Institute for Evolutionary Anthropology (MPI-EVA), Primatology, Deutscher Platz 6, 04103, Leipzig, Germany
85. M.G. Kholodny Institute of Botany NAS of Ukraine, Geobotany and Ecology, Tereshchenkivska 2, 01601, Kyiv, Ukraine
86. Masaryk University, Department of Botany and Zoology, Kotlářská 2, 611 37, Brno, Czech Republic
87. Peking University, College of Urban and Environmental Sciences, Yiheyuan Rd. 5, 100871, Beijing, China
88. Institute of Ecology of the Volga River Basin RAS, Dept. of the Phytodiversity Problems, Komzin str. 10, 445003, Togliatti, Russia
89. Leipzig University, Remote Sensing Centre for Earth System Research, Talstr. 6b, 07745, Leipzig, Germany
90. Aarhus University, Department of Bioscience, Grenaaavej 14, 8410, Roende, Denmark
91. Murdoch University, Harry Butler Institute, 90 South Street, Building 390, 6150, Murdoch, Australia
92. Royal Botanic Gardens, Kew, Conservation Science, Wakehurst Place, RH17 6TN, Ardingly, West Sussex, United Kingdom
93. IRD, CIRAD, CNRS, INRA, Université Montpellier, AMAP - Botany and Modelling of Plant Architecture and Vegetation, Boulevard de la Lironde, 34398, Montpellier, France
94. University of Vienna, Department of Botany and Biodiversity Research, Rennweg 14, 1030, Vienna, Austria

95. Polish Academy of Sciences, Botanical Garden - Center for Biological Diversity Conservation, Prawdziwka 2, 02-976, Warszawa, Poland
96. National Academy of Sciences of Ukraine, M.G. Kholodny Institute of Botany, Tereshchenkivska 2, 01601, Kyiv, Ukraine
97. Universidade Federal do Rio Grande do Sul, Department of Botany, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, Brazil
98. Universidad de Concepción, Laboratorio de Invasiones Biológicas (LIB). Facultad de Ciencias Forestales., Victoria 631, 4030000.0, Concepción, Chile
99. Institute of Ecology and Biodiversity (IEB), Chile
00. University of North Carolina, Department of Biology, CB3280, South Road, 27599-3280, Chapel Hill, NC, United States
01. University of Barcelona, Department of Evolutionary Biology, Ecology and Environmental Sciences, Diagonal 643, 08028, Barcelona, Spain
02. Center for Advanced Studies of Blanes, Spanish Research Council (CEAB-CSIC), Continental Ecology, Carrer d'accés a la Cala St. Francesc, 14, 17300, Blanes, Girona, Spain
03. University of the Andes, Department of Civil and Environmental Engineering, Carrera 1 Este No. 19A-40, Edificio Mario Laserna, Piso 6 , 111711, Bogota, Colombia
04. Kazan Federal University, Institute of Environmental Sciences, Kremlevskaya 18, 420008, Kazan, Russia
05. Nature Research Centre, Institute of Botany, Zaliuju Ezeru 49, 08406, Vilnius, Lithuania
06. Universidad San Francisco de Quito, COCIBA, Diego de Robles, 170177, Quito, Ecuador
07. NA, 7 Derwent Road, LA1 3ES, Lancaster, United Kingdom
08. Babeş-Bolyai University, Hungarian Department of Biology and Ecology, Faculty of Biology and Geology, Republicii street 42., 400015, Cluj-Napoca, Romania
09. University of Latvia, Department of Geography, 1 Jelgavas Street, 1004, Riga, Latvia
10. University of Bayreuth, Climatology, Bayreuth Center of Ecology and Environmental Research (BayCEER), Universitätsstr. 30, 95447, Bayreuth, Germany
11. Stadt Frankfurt am Main - Der Magistrat, Palmengarten, Siesmayerstraße 61, 60323, Frankfurt am Main, Germany
12. University of Nottingham, School of Geography, University Park, NG7 2RD, Nottingham, UK
13. Plant Science and Biodiversity Centre Slovak Academy of Sciences, Institute of Botany, Dubravská cesta 9, 84523, Bratislava, Slovakia
14. Research Centre of Slovenian Academy of Sciences and Arts (ZRC SAZU), Institute of Biology, Novi trg 2, 1000, Ljubljana, Slovenia
15. Department of Botany, Charles University, Benatska 2, 12801 Prague, Czech Republic
16. University of Zagreb, Faculty of Forestry, Svetošimunska 25, 10000, Zagreb, Croatia
17. University of Adelaide, TERN, North Terrace, 5005, Adelaide, Australia
18. Università degli Studi Roma TRE, Dipartimento di Scienze, viale G.Marconi 446, 00146, Rome, Italy
19. Centro de Investigaciones sobre Desertificación (CSIC-UV-GV), Carretera Moncada–Náquera km 4.5, 46113.0, Moncada (Valencia), Spain
20. University of Zagreb, Faculty of Geotechnical Engineering, Hallerova aleja 7, 42000, Varaždin, Croatia
21. Aarhus University, Department of Biology, Ny Munkegade 114, DK-8000, Aarhus C, Denmark
22. Yunnan University, School of Ecology and Environmental Science, Building Shixun, Chenggong Campus, Dongwaihuan South Road, University Town, Chenggong New District, 650504, Kunming, China
23. Aristotle University of Thessaloniki, School of Biology, 54124, Thessaloniki, Greece
24. University of Erlangen-Nuremberg, Department of Geography, Wetterkreuz 15, 91058, Erlangen, Germany
25. Universidade Federal do Rio Grande do Sul, Department of Ecology, Av Bento Gonçalves 9500, 91501-970, Porto Alegre, Brazil
26. University of Perugia, Department of Chemistry, Biology and Biotechnology, Borgo XX giugno 74, 06124, Perugia, Italy
27. Universidade Regional de Blumenau, Departamento de Engenharia Florestal, Rua São Paulo, 3250, 89030-000, Blumenau, Brazil
28. CNRS, UMR 5175 CEFE, 1919 route de Mende, 34293, Montpellier, France
29. University of Oulu, Ecology and Genetics Research Unit, Biodiversity Unit, Kaitoväylä 5, 90014, Oulu, Finland
30. Helmholtz Center for Environmental Research - UFZ, Department of Physiological Diversity, Permoserstr. 15, 04318, Leipzig, Germany
31. Leuphana University of Lüneburg, Institute of Ecology, Universitätsallee 1, 21335, Lüneburg, Germany
32. University of Alberta, Department of Biological Sciences, Biological Sciences Building, T6G2E9, Edmonton, Canada
33. University of Alaska, Institute of Arctic Biology, P. O. Box 7570000, 99775, Fairbanks, United States
34. Addis Ababa University, Department of Geography & Environmental Studies, Sidist Kilo SQ, 150178, Addis Ababa, Ethiopia
35. Hainan University, Key Laboratory of Tropical Biological Resources of Ministry of Education, School of Life and Pharmaceutical Sciences, 58 Renmin Avenue, Meilan District, 570228, Haikou, China
36. Senckenberg Museum of Natural History Görlitz, Botany Department, PO Box 300 154, 02806, Görlitz, Germany
37. Technische Universität Dresden, International Institute Zittau, Markt 23, 02763, Zittau, Germany
38. Brown University, Department of Ecology and Evolutionary Biology/Brown University Herbarium, 34 Olive Street, 02912, Providence, United States
39. Vienna Institute for Nature Conservation & Analyses, Giessergasse 6/7, 1090, Vienna, Austria

40. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Research Unit Forest Dynamics, Zürcherstrasse 111, 8903, Birmensdorf, Switzerland
41. Ufa Scientific Centre, Russian Academy of Sciences, Laboratory of Wild-Growing Flora, Botanical Garden-Institute, Mendeleev str., 195/3, 450080, Ufa, Russia
42. University of Tartu, Institute of ecology and earth sciences, Lai st 40, Tartu 51005, Estonia

Abstract

Vegetation provides the foundation of life on Earth. Assessing biodiversity status and trends in plant communities is therefore critical to understand and quantify the effects of global change on ecosystems. Here, we present the largest dataset of vegetation plots (i.e. species co-occurrence or community composition data) ever released in open access. It contains information on 91,031 vegetation plots recording the cover or abundance of each vascular plant species that occurs in a plot of a given surface area at the date of the botanical survey. Plots were derived from 103 local to regional datasets. To improve the representation of Earth's environmental conditions, plots were resampled from a larger pool of vegetation plots using an environmentally stratified sampling design. Each vegetation plot comes with information on community-weighted means and variances of key plant functional traits. Our open-access dataset 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.

Background & Summary

Biodiversity is facing a global crisis (1). As many as 1 million species are estimated to be already facing extinction, the far majority due to anthropogenic impacts, land-use and climate change (1). The rates of biodiversity redistribution and homogenization are accelerating (2, 3; 4). Biological assemblages are becoming progressively more similar to each other globally, as local biodiversity and endemic species go extinct and are replaced by more widespread and competitive native or alien species (1; 4). This has profound potential impacts on human and ecosystem health (5; 6). For instance, many terrestrial and marine species are shifting their geographical distribution as a response to climate change (3), including animals hosting pathogens transmissible to humans (7; 8; 9).

Vegetation, i.e., the assemblage of plant species, is no exception to this biodiversity crisis (10; 11; 4). This is worrisome 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, stability and functioning (11), assessing biodiversity status and trends in plant communities is paramount for other life compartments and human societies alike.

Monitoring plant biodiversity trends requires adequate data across a range of 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, all these occurrence-only databases either neglect how individual plant species co-occur and interact locally to form plant communities, or are collected at spatial resolutions (e.g., one-degree grid cells) which are too coarse to assess biodiversity trends at the most relevant scale of local plant communities (17).

Yet, there is a long-lasting tradition among botanists to record the cover or abundance of each plant species that occurs in a vegetation plot of a given size (i.e. surface area) at a given time (e.g. 18). Compared to species-level data, vegetation plot data present many advantages. First, they contain information on which plant species co-occur together in the same locality at a given moment in time (19). This built-in feature of vegetation plots is a necessary prerequisite for testing hypotheses related to biotic interactions among plant species (i.e. plant-plant interactions). It can also provide crucial information on where and when a species is absent, therefore improving 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, 4). As they normally contain also information on the relative cover or abundance of each species, vegetation plots are more adequate to detect biodiversity changes, compared to data based on the occurrence of individual species only (23).

Vegetation-plot data are very fragmented, though, as they typically stem from a myriad of research projects (24). As such, these data often suffer from the usual trade-off in biodiversity data: collections have either fine-grain spatial resolutions but small spatial extents, or vice versa (25). Furthermore, with their disparate sampling protocols, standards and taxonomic resolutions, aggregating and harmonizing vegetation plot data proves extremely challenging (26). It is not surprising, therefore, that these data have only been rarely used in global-scale biodiversity research until recently (27; 28).

The sPlot initiative tries to close this data gap. It leverages several existing local to regional vegetation-plot datasets to create a harmonized and comprehensive global geo-database of terrestrial plant species assemblages (24). Established in 2013, sPlot currently contains more than 1.9 million vegetation plots, and is fully integrated with the TRY database (29), from which it derives information on plant functional traits. The sPlot database is increasingly being used to study continental- to global-scale vegetation patterns, such as the relative contribution of regional vs. local factors on the global patterns of fern richness (30), the mechanisms underlying the spread and abundance of native

vs. invasive tree species ([31](#)), and worldwide trait–environment relationships in plant communities ([26](#)).

Here, we provide an open-access data set composed of 91,031 vegetation plots, representative of the environmental space covered by the sPlot database. The selected vegetation plots stem from 103 databases and span across 115 countries (Figure [1](#)). This resampled dataset (sPlot Open - 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 diversity indices derived from the TRY database ([29](#)).

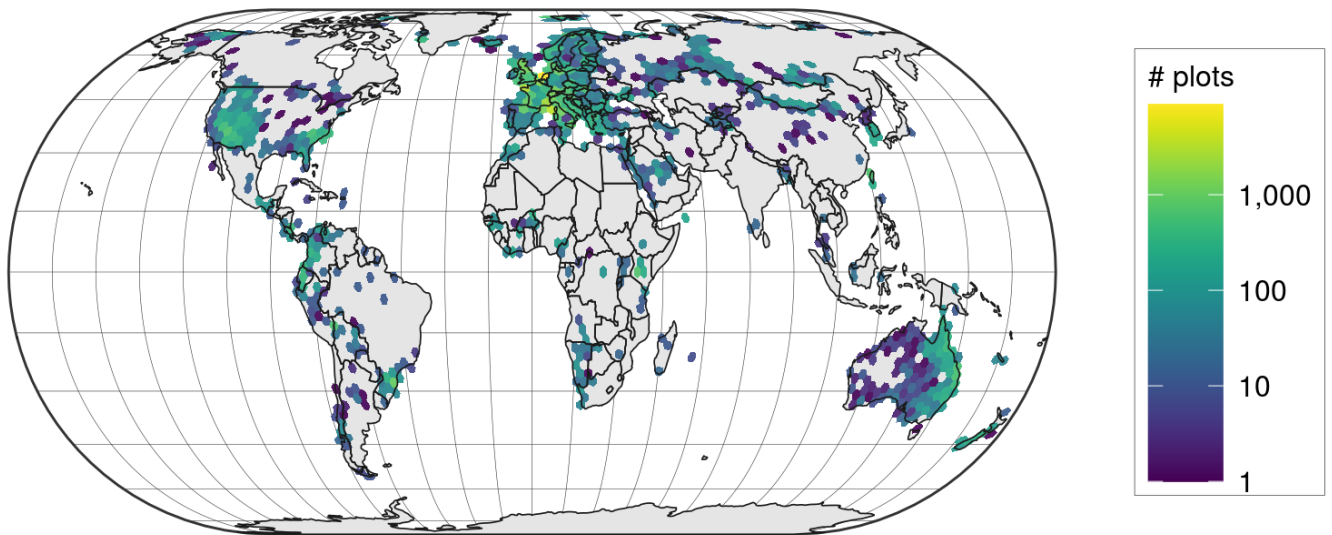


Figure 1: Global map of sPlot Open ($n = 91,031$) and spatial distribution of vegetation plot density per hexagonal cell with a spatial resolution of approximately $70,000 \text{ km}^2$. Map projection is Eckert IV.

Methods

Vegetation plot data sources

We started from the sPlot database v2.1 (created October 2016), which contains 1,121,244 vegetation plots and 23,586,216 species records stemming from 110 different vegetation-plot datasets of regional, national or continental extent. Some of the 110 datasets stem from regional or continental initiatives (see [24](#) 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 derive from the VegBank archive ([32](#); [33](#)). 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](#) ([34](#)), using the GIVD identifier as the unique dataset identifier.

Resampling method

Data in the sPlot database are unevenly distributed across continents and biomes (see [26](#)). Mid-latitude regions in developing countries (mostly Europe, the USA and Australia) are overrepresented, while regions in the tropics and subtropics are underrepresented, which is a typical geographical bias in biodiversity data (e.g., [35](#); [3](#)). To reduce this imbalance to the extent 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 ([36](#)), as well as two variables reflecting growing-season warmth (growing degree days above 1 °C - GDD1 - and 5 °C - GDD5), which we calculated based on CHELSA bioclimatic variables. In addition, we considered an index of aridity (AR) and a model for Potential Evapotranspiration (PET - [37](#)). For soil, we extracted seven variables from the SOILGRIDS database ([38](#)), 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) of 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. We then subdivided the environmental space represented by the first two principal components (PC1-PC2), accounting for 47% and 23% of the total variation on PC1 and PC2, respectively, into a 100 × 100 grid. This PC1-PC2 bidimensional space was subsequently used to balance our sampling effort across all PC1-PC2 grid cells for which vegetation plots are available. Before projecting vegetation plots from the sPlot database v2.1 onto this PC1-PC2 environmental space, we removed vegetation plots: from wetlands; from anthropogenic vegetation types; without geographical coordinates; and with a location uncertainty higher than 3 km for those having geographical coordinates. This led to a total of 799,400 out of the initial set of 1,121,244 vegetation plots. When projecting the 799,400 vegetation plots in the PC1-PC2 grid, we calculated how many vegetation plots occurred in each PC1-PC2 grid cell. For those grid cells with more than 50 vegetation plots ($n = 858$), we randomly selected up to 50 vegetation plots using the heterogeneity-constrained random resampling algorithm from Lengyel et al. (2011) [[39](#)]. 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 based the quantification of 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 ([40](#)) between all possible pairs of vegetation plots for a given random selection of 50 vegetation plots ($n = 1225$). 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 random selection with the lowest summed rank was considered the most representative of the focal grid cell. In case a grid cell contained fewer 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 random 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).

Permission to release the data as open access

The resampling procedure resulted in a preliminary potential selection of 98,383 vegetation plots (first choice) and 51,634 vegetation plots flagged as reserves (second or third choice for the subset of PC1-PC2 grid cells with more than 50 vegetation plots available). Being, the sPlot database, 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 8,070 vegetation plots, permission could not be granted because, for instance, the data are unpublished, confidential or sensitive. 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 vegetation plot in the reserve should belong to the same environmental stratum, i.e., the same PC1-PC2 grid cell, of the confidential vegetation plot. Note that 2,380 PC1-PC2 grid cells (11.7% of total) had one or more confidential vegetation plot (median = 1, mean = 3.4, max = 171) that could not be replaced from the reserve pool.

Trait information

For each vegetation plot for which open access has been granted, we computed the community weighted means for eighteen plant functional traits derived from the TRY database v3.0 ([29](#)). These traits were selected among those traits that describe the leaf, wood and seed economics spectra ([41](#); [42](#)), and are known to either affect different key ecosystem processes or respond to macroclimatic drivers or both ([24](#)). The eighteen plant functional traits were: (1) leaf area [mm^2]; (2) stem specific density [g cm^{-3}]; (3) specific leaf area [m^2kg^{-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 $\delta^{15}\text{N}$ [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 employed a gap-filling procedure based on hierarchical Bayesian modeling (R package 'BHPMF', [43](#); [44](#)). Gap-filling was performed at the level of individual observations. We then transformed to the natural logarithm all gap-filled trait values and averaged each trait by taxon (i.e., at species, or genus level). Additional information on the gap-filling procedure is available in [[24](#)].

Community-weighted means (CWM) and variances (CWV) were calculated for every plant functional trait j and every vegetation plot k as follows ([45](#)):

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

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

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

Data Records

The final dataset that is provided here as open access contains 91,031 vegetation plots from 115 countries and all continents except Antarctica (Figure 1). This randomized selection stems from 103 constitutive datasets (Table 1). It only contains the species composition of vascular plants, while information on the composition of bryophytes and lichens was discarded since it was only available for a minority of plots ($n = 4,963$ and $n = 3,045$, respectively). Information on the size (surface area) of the vegetation survey is available for 61,898 vegetation plots, and ranges between 0.01 m^2 and 4 ha (mean = 270 m^2 ; median = 78.5 m^2). The average number of vascular plant species per vegetation plot ranges between 1 (i.e. monospecific stands) and 270 species (mean = 17.6; median = 13).

By reducing the overrepresentation of vegetation plots in specific 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. Europe is by far the best represented continent, with 53,884 vegetation plots. In contrast, Africa and South America have only 4,507 and 5,515 vegetation plots, respectively. The representation of biomes is equally unbalanced. The biomes 'Temperate midlatitudes' and 'Subtropics with winter rain' have 37,507 and 16,510 vegetation plots, respectively, while none of the other biomes have more than 10,000 vegetation plots (Figure 2). Yet all Whittaker biomes are covered by sPlot Open.



Figure 2: Distribution of all the vegetation plots provided by sPlot Open ($n = 91,031$) in the bi-dimensional climatic space represented by mean annual temperature and mean annual precipitation superimposed onto Whittaker biomes (46)

Finally, the dataset contains a relatively balanced number of forest ($n = 25,832$) vs. non forest ($n = 38,203$) vegetation plots, with a minor proportion of plots remaining unassigned ($n = 10,050$). The

assignment of plots to forests and non-forests is 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 a 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 instead 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) [[24](#)]. 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 invite potential users to carefully read the description of each individual dataset in [GIVD](#), or to contact the custodians of each dataset before using sPlot Open.

Database Organization

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

The **'header'** matrix contains plot-level information for the 91,031 vegetation plots provided in this open access dataset, 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) and vegetation type. 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) ([47](#)). For each vegetation plot we further provide information on the dataset it stems from, based on the IDs used in [GIVD](#). A brief description of all the 43 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 1,608,610 records from 39,997 vascular plant taxa, mostly resolved at the species level. For each record, we report both the taxon name as originally contributed by the data custodian (column *'Original_species'*), and the taxon name after taxonomic standardization (column *'Species'*). For each record, we report the species 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 (m²/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 = 1,397,109). 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 20,932 species. The average proportion of species in each plot for which we have functional trait information is 0.88 (median = 1). For 47,177 plots, the coverage is complete, while only in one plot we have no functional trait information for any of the occurring species. When considering relative cover, the average trait coverage is 0.89. As many as 68,234 and 74,388 plots have functional trait information for more than 80% of the species or 80% of relative cover, respectively.

sPlot Open 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'* - [34](#)), 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 case of nested plots (n = 1,786), 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 sPlot database has a nested structure and is composed of several individual datasets, each validated and maintained by its respective dataset custodian. In some 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 or grey literature. We obviously have no direct control over the individual vegetation plots that we provide here in an open-access dataset. Yet, each of 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 having been integrated into the sPlot database, each dataset was further checked for consistency and, if having a different format, was converted to a Turboveg 2 database (48). 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. Finally, we harmonized all the taxonomic names from all datasets, based on the sPlot's taxonomic backbone (49). This backbone matched all the taxonomic names (without nomenclatural authors) from all datasets in sPlot 2.1 and TRY v3.0 (29) to their resolved version based on the Taxonomic Name Resolution Service web application (TNRS version 4.0; 50; iPlant Collaborative, 2015). This allowed to (1) harmonize all datasets to a common nomenclature, and (2) link the sPlot database to the TRY database (29). All taxa originally denoted at taxonomic ranks lower than species were aggregated at species level. Additional detail on the taxonomic resolution is reported in Bruelheide et al. (2019) [24], while a description of the workflow, including R-code, is available in Purschke (2017) [49].

Usage Notes

The sPlot Open database can be downloaded from <https://www.idiv.de> (link to PlantHub). Users are invited to cite the original sources when using sPlot Open. For two datasets (e.g., AF-00-009, AF-CD-001), the identification of taxa at species level is still in progress. As a rule, we recommend sPlot Open users 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 use of data contained in BioTIME (51) should cite original data citations in addition to the present paper. 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).

Code Availability

The R code used to produce sPlot Open 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 (52). The code for reproducing this manuscript is stored in the *sPlotOpen_manuscript* GitHub repository: (https://github.com/fmsabatini/sPlotOpen_Manuscript).

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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 v3 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. All authors contributed to revising the manuscript.

Competing interests

The authors declare no competing interests.

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82. **Vegetation Database Grassland Vegetation of Serbia**
Svetlana Ačić, Milicia Petrović, Urban Šilc, Zora Dajić Stevanović
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83. **Lower Volga Valley Phytosociological Database**
Alexey Sorokin, Valentin Golub, Kseniya Starichkova, Lyudmila Nikolaychuk, Viktoria Bondareva,

Tatyana Ivakhnova
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DOI: [10.7809/b-e.00208](https://doi.org/10.7809/b-e.00208)

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Vadim Prokhorov, Tatiana Rogova, Maria Kozhevnikova
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Elizabeth Kearsley, Thales de Haulleville, Koen Hufkens, Alidé Kidimbu, Benjamin Toirambe, Geert Baert, Dries Huygens, Yodit Kebede, Pierre Defourny, Jan Bogaert, ... Hans Verbeeck
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101. **Vegetation of the woodland-steppe transition at the southeastern edge of the Inner Mongolian Plateau**
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104. **Vegetation Database of Sinai in Egypt**
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107. **Wetland Vegetation Database of Baikal Siberia (WETBS)**
Victor Chepinoga
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DOI: [10.7809/b-e.00107](https://doi.org/10.7809/b-e.00107)
108. **Eastern Pamirs – A vegetation-plot database for the high mountain pastures of the Pamir Plateau (Tajikistan)**
Kim André Vanselow
Phytocoenologia (2016-06-01) <https://doi.org/f952sp>
DOI: [10.1127/phyto/2016/0122](https://doi.org/10.1127/phyto/2016/0122)
109. **Socotra Vegetation Database**
Michele De Sanctis, Fabio Attorre
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111. **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

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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
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115. **Timberline meadows along a 1000-km transect in NW North America: species diversity and community patterns**
Viktoria Wagner, Toby Spribille, Stefan Abrahamczyk, Erwin Bergmeier
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116. **How resilient are northern hardwood forests to human disturbance? An evaluation using a plant functional group approach**
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117. **Vegetation and altitudinal zonation in continental West Greenland**
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118. **VegBank – a permanent, open-access archive for vegetation-plot data**
Robert Peet, Michael Lee, Michael Jennings, Don Faber-Langendoen
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DOI: [10.7809/b-e.00080](https://doi.org/10.7809/b-e.00080)
119. **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>
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120. **The Alaska Arctic Vegetation Archive (AVA-AK)**
Donald A. Walker, Amy L. Breen, Lisa A. Druckenmiller, Lisa W. Wirth, Will Fisher, Martha K. Reynolds, Jozef Šibík, Marilyn D. Walker, Stephan Hennekens, Keith Boggs, ... Donatella Zona
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Supplementary Material

Table 1: List of databases contributing to 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. OA plots	Ref
00-00-004	Vegetation Database of Eurasian Tundra	Risto Virtanen		600	
00-RU-003	Database Meadows and Steppes of Southern Ural	Sergey Yamalov	Mariya Lebedeva	99	
00-TR-001	Forest Vegetation Database of Turkey - FVDT	Ali Kavgacı		15	
EU-00-002	Nordic-Baltic Grassland Vegetation Database (NBGVD)	Jürgen Dengler	Łukasz Kozub	931	53
EU-00-011	Vegetation-Plot Database of the University of the Basque Country (BIOVEG)	Idoia Biurrun	Itziar García-Mijangos	1694	54
EU-00-013	Balkan Dry Grasslands Database	Kiril Vassilev	Armin Macanović	224	55
EU-00-016	Mediterranean Ammophiletea Database	Corrado Marcenò	Borja Jiménez-Alfaro	3713	56
EU-00-017	European Coastal Vegetation Database	John Janssen		1369	
EU-00-018	The Nordic Vegetation Database	Jonathan Lenoir	Jens-Christian Svenning	1755	57
EU-00-019	Balkan Vegetation Database	Kiril Vassilev	Hristo Pedashenko	211	58
EU-00-020	WetVegEurope	Flavia Landucci		61	59
EU-00-022	European Mire Vegetation Database	Tomáš Peterka	Martin Jiroušek	1843	60
EU-AL-001	Vegetation Database of Albania	Michele De Sanctis	Giuliano Fanelli	99	61
EU-AT-001	Austrian Vegetation Database	Wolfgang Willner	Christian Berg	950	62
EU-BE-002	INBOVEG	Els De Bie		48	
EU-BG-001	Bulgarian Vegetation Database	Iva Apostolova	Desislava Sopotlieva	74	63
EU-CH-005	Swiss Forest Vegetation Database	Thomas Wohlgemuth		1409	64
EU-CZ-001	Czech National Phytosociological Database	Milan Chytrý	Ilona Knollová	579	65
EU-DE-001	VegMV	Florian Jansen	Christian Berg	5	66
EU-DE-013	VegetWeb Germany	Florian Jansen	Jörg Ewald	199	67
EU-DE-014	German Vegetation Reference Database (GVRD)	Ute Jandt	Helge Bruelheide	286	68
EU-DK-002	National Vegetation Database of Denmark	Jesper Erenskjold Moeslund	Rasmus Ejrnæs	1181	
EU-ES-001	Iberian and Macaronesian Vegetation Information System (SIVIM) - Wetlands	Aaron Pérez-Haase	Xavier Font	292	
EU-FR-003	SOPHY	Emmanuel Garbolino	Patrice De Ruffray	13322	69

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. OA plots	Ref
EU-GB-001	UK National Vegetation Classification Database	John S. Rodwell		5457	
EU-GR-001	KRITI	Erwin Bergmeier		43	
EU-GR-005	Hellenic Natura 2000 Vegetation Database (HelNatVeg)	Panayotis Dimopoulos	Ioannis Tsiripidis	777	70
EU-GR-006	Hellenic Woodland Database	Ioannis Tsiripidis	Georgios Fotiadis	4	71
EU-HR-001	Phytosociological Database of Non-Forest Vegetation in Croatia	Zvezdana Stančić		213	72
EU-HR-002	Croatian Vegetation Database	Željko Škvorc	Daniel Krstonošić	688	
EU-HU-003	CoenoDat Hungarian Phytosociological Database	János Csiky	Zoltán Botta-Dukát	17	73
EU-IT-001	VegItaly	Roberto Venanzoni	Flavia Landucci	2712	74
EU-IT-010	Italian National Vegetation Database (BVN/ISPRA)	Laura Casella	Pierangela Angelini	155	75
EU-IT-011	Vegetation-Plot Database Sapienza University of Rome (VPD-Sapienza)	Emiliano Agrillo	Fabio Attorre	1003	76
EU-LT-001	Lithuanian Vegetation Database	Valerijus Rašomavičius	Domas Uogintas	119	
EU-LV-001	Semi-natural Grassland Vegetation Database of Latvia	Solvita Rūsiņa		306	77
EU-MK-001	Vegetation Database of the Republic of Macedonia	Renata Ćušterevska		10	
EU-NL-001	Dutch National Vegetation Database	Joop H.J. Schaminée	Stephan M. Hennekens	10223	78
EU-PL-001	Polish Vegetation Database	Zygmunt Kącki	Grzegorz Swacha	464	79
EU-RO-007	Romanian Forest Database	Adrian Indreica	Pavel Dan Turtureanu	60	80
EU-RO-008	Romanian Grassland Database	Eszter Ruprecht	Kiril Vassilev	44	81
EU-RS-002	Vegetation Database Grassland Vegetation of Serbia	Svetlana Ačić	Zora Dajić Stevanović	57	82
EU-RU-002	Lower Volga Valley Phytosociological Database	Valentin Golub	Andrey Chuvashov	149	83
EU-RU-003	Vegetation Database of the Volga and the Ural Rivers Basins	Tatiana Lysenko		96	84
EU-RU-011	Vegetation Database of Tatarstan	Vadim Prokhorov	Maria Kozhevnikova	94	85
EU-SI-001	Vegetation Database of Slovenia	Urban Šilc	Filip Kuzmič	435	86
EU-SK-001	Slovak Vegetation Database	Milan Valachovič	Jozef Šibík	893	87
EU-UA-006	Vegetation Database of Ukraine and Adjacent Parts of Russia	Viktor Onyshchenko	Vitaliy Kolomiychuk	479	
AF-00-001	West African Vegetation Database	Marco Schmidt	Georg Zizka	184	88
AF-00-008	PANAF Vegetation Database	Hjalmar Kühl	TeneKwetché Sop	942	

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. OA plots	Ref
AF-BF-001	Sahel Vegetation Database	Jonas V. Müller	Marco Schmidt	279	89
00-00-001	ForestPlots.net	Oliver L. Phillips	Aurora Levesley	108	90
00-00-003	SALVIAS	Brian Enquist	Brad Boyle	2860	
00-00-005	Tundra Vegetation Plots (TundraPlot)	Anne D. Bjorkman	Sarah Elmendorf	227	91
00-RU-002	Database of Masaryk University`s Vegetation Research in Siberia	Milan Chytrý		128	92
AF-00-003	BIOTA Southern Africa Biodiversity Observatories Vegetation Database	Norbert Jürgens	Ute Schmiedel	562	93
AF-00-006	SWEA-Dataveg	Miguel Alvarez	Michael Curran	1211	
AF-00-009	Vegetation Database of the Okavango Basin	Rasmus Revermann	Manfred Finckh	202	94
AF-CD-001	Forest Database of Central Congo Basin	Kim Sarah Jacobsen	Hans Verbeeck	97	95
AF-ET-001	Vegetation Database of Ethiopia	Desalegn Wana	Anke Jentsch	59	96
AF-MA-001	Vegetation Database of Southern Morocco	Manfred Finckh		266	97
AF-ZW-001	Vegetation Database of Zimbabwe	Cyrus Samimi		17	98
AS-00-001	Korean Forest Database	Tomáš Černý	Jiri Dolezal	766	99
AS-00-003	Vegetation of Middle Asia	Arkadiusz Nowak	Marcin Nobis	128	100
AS-00-004	Rice Field Vegetation Database	Arkadiusz Nowak		31	
AS-BD-001	Tropical Forest Dataset of Bangladesh	Mohammed A.S. Arfin Khan	Fahmida Sultana	82	
AS-CN-001	China Forest-Steppe Ecotone Database	Hongyan Liu	Fengjun Zhao	97	101
AS-CN-002	Tibet-PaDeMoS Grazing Transect	Karsten Wesche		27	102
AS-CN-003	Vegetation Database of the BEF China Project	Helge Bruelheide		18	103
AS-CN-004	Vegetation Database of the Northern Mountains in China	Zhiyao Tang		70	
AS-EG-001	Vegetation Database of Sinai in Egypt	Mohamed Z. Hatim		98	104
AS-ID-001	Sulawesi Vegetation Database	Michael Kessler		24	
AS-IR-001	Vegetation Database of Iran	Jalil Noroozi	Parastoo Mahdavi	105	
AS-KZ-001	Database of Meadow Vegetation in the NW Tien Shan Mountains	Viktoria Wagner		3	105
AS-MN-001	Southern Gobi Protected Areas Database	Henrik von Wehrden	Karsten Wesche	688	106
AS-RU-001	Wetland Vegetation Database of Baikal Siberia (WETBS)	Victor Chepinoga		6	107
AS-RU-002	Database of Siberian Vegetation (DSV)	Andrey Korolyuk	Andrei Zverev	2150	

GIVD ID	Dataset name	Custodian	Deputy custodian	Nr. OA plots	Ref
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	85	
AS-SA-001	Vegetation Database of Saudi Arabia	Mohamed Abd El-Rouf Mousa El-Sheikh		607	
AS-TJ-001	Eastern Pamirs	Kim André Vanselow		174	108
AS-TW-001	National Vegetation Database of Taiwan	Ching-Feng Li	Chang-Fu Hsieh	897	
AS-YE-001	Socotra Vegetation Database	Michele De Sanctis	Fabio Attorre	190	109
AU-AU-002	AEKOS	Anita Smyth	Ben Sparrow	7443	110
AU-NC-001	New Caledonian Plant Inventory and Permanent Plot Network (NC-PIPPN)	Jérôme Munzinger	Philippe Birnbaum	98	111
AU-NZ-001	New Zealand National Vegetation Databank	Susan Wiser		983	112
AU-PG-001	Forest Plots from Papua New Guinea	Timothy Whitfeld	George D. Weiblen	53	113
NA-00-002	Tree Biodiversity Network (BIOTREE-NET)	Luis Cayuela		208	114
NA-CA-003	Database of Timberline Vegetation in NW North America	Viktoria Wagner	Toby Spribille	38	115
NA-CA-004	Understory of Sugar Maple Dominated Stands in Quebec and Ontario (Canada)	Isabelle Aubin		9	116
NA-CA-005	Boreal Forest of Canada	Yves Bergeron	Louis De Grandpré	44	
NA-GL-001	Vegetation Database of Greenland	Birgit Jedrzejek	Fred J.A. Daniëls	340	117
NA-US-002	VegBank	Robert K. Peet	Michael T. Lee	6456	118
NA-US-006	Carolina Vegetation Survey Database	Robert K. Peet	Michael T. Lee	2317	119
NA-US-014	Alaska-Arctic Vegetation Archive	Donald A. Walker	Amy Breen	467	120
SA-00-002	VegPáramo	Gwendolyn Peyre	Xavier Font	1591	121
SA-AR-002	Vegetation Database of Central Argentina	Melisa Giorgis	Alicia Acosta	42	
SA-BO-003	Bolivia Forest Plots	Michael Kessler	Sebastian Herzog	18	
SA-BR-002	Forest Inventory, State of Santa Catarina, Brazil (IFFSC Project)	Alexander Christian Vibrans	André Luis de Gasper	1345	122
SA-BR-003	Grasslands of Rio Grande do Sul, Brazil	Eduardo Vélez-Martin	Valério De Patta Pillar	271	
SA-BR-004	Grassland Database of Campos Sulinos	Gerhard E. Overbeck	Valério De Patta Pillar	111	
SA-CL-002	SSAForests_Plots_db	Alvaro G. Gutierrez		163	
SA-CL-003	Chilean Park Transects - Fondecyt 1040528	Aníbal Pauchard	Alicia Marticorena	33	123
SA-EC-001	Ecuador Forest Plot Database	Jürgen Homeier		156	

Table 2: Description of the variables contained in the 'header' matrix, together with their range (if numeric) or possible levels (if nominal or binary). Variable types can be n - nominal (i.e., qualitative variable), o - ordinal, q - quantitative, or b - binary (i.e., boolean), or d - date.

Variable	Range/Levels	Unit of Measurement	Nr. Records	Type
GIVD_ID			91031	n
Dataset			91031	n
Continent	Africa, Asia, Australia, Europe, North America, Oceania, South America		90729	n
Country			91031	n
Biome	Alpine, Boreal zone, Dry midlatitudes, Dry tropics and subtropics, Polar and subpolar zone, Subtrop. with year-round rain, Subtropics with winter rain, Temperate midlatitudes, Tropics with summer rain, Tropics with year-round rain		91031	n
Date_of_recording	1888-07-05 - 2015-02-03	dd-mm-yyyy	75798	d
Latitude	-54.73863 - 80.149116	° (WGS84)	91031	q
Longitude	-162.741433 - 179.590053	° (WGS84)	91031	q
Location_uncertainty	1 - 2500	m	91002	q
Releve_area	0.01 - 40000	m ²	61898	q
Herbs_identified	FALSE = 4876; TRUE = 6323		11199	b
Plant_recorded	All trees & dominant understory, All vascular plants, All vascular plants and dominant cryptogams, All woody plants, Dominant trees, Only dominant species, Dominant woody plants >= 2.5 cm dbh, Woody plants >= 10 cm dbh, Woody plants >= 1 m height, Woody plants >= 1 cm dbh, Woody plants >= 20 cm dbh, Woody plants >= 2.5 cm dbh, Woody plants >= 5 cm dbh, NA		91015	n
Elevation	-25 - 4819	m a.s.l.	52121	q
Aspect	0 - 360	°	30796	q
Slope	0 - 99	°	37784	q
is_forest	FALSE = 20396; TRUE = 25832		46228	b
is_nonforest	FALSE = 50870; TRUE = 38203		89073	b
ESY			55457	n
Forest	0 - 1		73882	q
Shrubland	0 - 1		73882	q
Grassland	0 - 1		73882	q
Wetland	0 - 1		73882	q
Sparse_vegetation	0 - 1		73882	q
Naturalness	1 = Natural, 2 = Semi-natural, 3 = Anthropogenic		68011	o
Cover_total	1 - 313	%	24712	q
Cover_tree_layer	0.5 - 150	%	7245	q
Cover_shrub_layer	0.5 - 145	%	10197	q
Cover_herb_layer	0.2 - 180	%	26679	q
Cover_moss_layer	1 - 100	%	9643	q

Variable	Range/Levels	Unit of Measurement	Nr. Records	Type
Cover_lichen_layer	1 - 95	%	734	q
Cover_algae_layer	1 - 100	%	221	q
Cover_litter_layer	1 - 100	%	4500	q
Cover_bare_rocks	1 - 100	%	1897	q
Cover_cryptogams	1 - 95	%	593	q
Cover_bare_soil	0.1 - 99	%	1412	q
Height_trees_highest	1 - 99	m	6115	q
Height_trees_lowest	1 - 90	m	221	q
Height_shrubs_highest	0.1 - 9.9	m	2880	q
Height_shrubs_lowest	0.1 - 9	m	328	q
Height_herbs_average	0.1 - 440	cm	10125	q
Height_herbs_lowest	1 - 250	cm	2785	q
Height_herbs_highest	1 - 600	cm	1733	q