

Supporting Information to the paper Biurrun I. et al. Benchmarking plant diversity of Palaearctic grasslands and other open habitats. *Journal of Vegetation Science*.

Appendix S2. Complementary information on the data.

Table S2.1. Countries or other territories arranged by decreasing plot density in the complete dataset.

N_{all} : total number of plots; $N_{\text{ind.}}$: number of independent observations.

Country	N_{all}	$N_{\text{ind.}}$	Area [km ²]	$N_{\text{all}} / 100$ km ²	$N_{\text{ind.}} / 100$ km ²
San Marino	273	147	61	447.54	240.98
Switzerland	7005	6289	41,285	16.97	15.23
Andorra	77	77	468	16.45	16.45
Austria	8639	2312	83,855	10.30	2.76
Spain	31957	5107	504,790	6.33	1.01
Hungary	3733	2953	93,030	4.01	3.17
Sweden	15667	2015	440,940	3.55	0.46
Estonia	1374	990	45,100	3.05	2.20
Italy	8687	1710	301,245	2.88	0.57
Israel	489	82	20,724	2.36	0.40
Azerbaijan	2033	2033	86,600	2.35	2.35
Norway	7374	1038	323,758	2.28	0.32
Germany	7649	5394	356,840	2.14	1.51
Armenia	443	263	29,743	1.49	0.88
Czech Republic	1089	569	78,864	1.38	0.72
Poland	3141	2805	312,685	1.00	0.90
Netherlands	306	9	41,865	0.73	0.02
Serbia	533	341	77,453	0.69	0.44
Romania	1402	957	238,397	0.59	0.40
Iran	9591	3066	1,648,195	0.58	0.19
Bulgaria	626	536	110,910	0.56	0.48

United Kingdom	1344	624	244,587	0.55	0.26
Slovakia	245	215	49,035	0.50	0.44
Svalbard and Jan Mayen	280	280	61,397	0.46	0.46
Ukraine	2677	1303	603,628	0.44	0.22
Croatia	227	227	56,594	0.40	0.40
Latvia	250	250	64,589	0.39	0.39
France (metropolitan)	1897	697	551,695	0.34	0.13
Belgium	90	90	30,688	0.29	0.29
Greece	385	301	131,957	0.29	0.23
Slovenia	41	41	20,273	0.20	0.20
Denmark (proper)	84	8	42,933	0.20	0.02
Tajikistan	260	140	143,100	0.18	0.10
Nepal	252	252	147,516	0.17	0.17
Portugal	132	60	92,212	0.14	0.07
Bosnia and Herzegovina	72	72	51,129	0.14	0.14
Japan	418	418	377,975	0.11	0.11
Turkey	491	311	783,356	0.06	0.04
Belarus	102	102	207,595	0.05	0.05
Kyrgyzstan	91	49	199,951	0.05	0.02
Cyprus	4	4	9,251	0.04	0.04
Mongolia	513	513	1,566,000	0.03	0.03
India	753	753	3,287,263	0.02	0.02
Russia	2434	1879	17,098,246	0.01	0.01
Ireland	12	12	84,421	0.01	0.01
Kazakhstan	364	364	2,724,900	0.01	0.01
China	982	755	9,596,961	0.01	0.01
Morocco	32	32	710,850	0.01	0.01
Finland	4	4	338,455	0.01	0.01

Table S2.2. Two-level vegetation typology applied in GrassPlot. Following Dengler et al. (2020), we consider natural grasslands those occurring in places where the natural vegetation would also be a grassland, though the current grasslands are potentially modified through human land use. We consider as secondary those grasslands occurring in places where the natural vegetation is forest, shrubland, heathland or wetland, after human land use like mowing, grazing, burning or abandoning arable fields. Secondary grasslands include both semi-natural grasslands and strongly intensified grasslands. In semi-natural grasslands site conditions remained more or less unaltered, e.g., no or very little artificial fertilization and no regular reseeding are applied. In strongly intensified grasslands, on the contrary, site conditions were strongly altered compared to the natural stage; in particular, with high land-use intensity to increase yield enabled through artificial fertilization.

Since the assignments to the fine-level vegetation types were largely based on syntaxonomy, and these fine-level types are fully nested in the coarse-level categories, there are some grey zones, e.g. some meso-xeric grasslands might be natural, and some rocky, alpine and xeric grasslands might be secondary. Similarly, fen meadows are included in wetlands and azonal communities, as the entire phytosociological class *Scheuchzerio-Caricetea fuscae* is assigned to wetlands.

Coarse-level	Fine-level
A. Natural grasslands	<p>A.1 <i>Alpine grasslands</i>. Grasslands above the timberline, in areas which are too cold to support forest growth</p> <p>A.2 <i>Alpine steppes</i>. Grasslands in the alpine belt of the steppe zone, e.g., in areas too dry and also too cold to support forest growth.</p> <p>A.3 <i>Xeric grasslands and steppes</i>. Grasslands in areas which are too dry to support forest growth and are affected by frost. They are zonal in the Dry midlatitudes, and extrazonal in the Boreal zone and Temperate midlatitudes, where they mostly occur on steep south-facing slopes.</p> <p>A.4 <i>Rocky grasslands</i>. Natural grasslands on shallow rocky substrates.</p>
B. Secondary grasslands	<p>B.1 <i>Sandy dry grasslands</i>. Dry grasslands on sandy soils. Some may be natural grasslands.</p> <p>B.2 <i>Meso-xeric grasslands</i>. Dry semi-natural grasslands growing on meso-xeric soils.</p> <p>B.3 <i>Mesic grasslands</i>. Meadows and pastures on humid but well-drained soils</p> <p>B.4 <i>Wet grasslands</i>. Wet meadows and rushes in temporarily wet areas and floodplains.</p> <p>B.5 <i>Mediterranean grasslands</i>. Dry grasslands in Mediterranean climate, rich in therophytes</p>

C. Azonal communities	<p>C.1 <i>Dunes</i>. Vegetation of coastal dunes.</p> <p>C.2 <i>Rocks and screes</i>. Sparse vegetation on rock crevices and screes.</p> <p>C.3 <i>Saline communities</i>. Vegetation of coastal and inland salt marshes</p> <p>C.4 <i>Saline steppes and semi-deserts</i>. Sparse vegetation on saline soils in semi-arid areas.</p> <p>C.5 <i>Wetlands</i>. Natural vegetation on waterlogged or flooded soils in marshes, mires and springs. Aquatic vegetation s.s. not included.</p>
D. Dwarf shrublands	<p>D.1 <i>Lowland heathlands</i>. Secondary heathlands.</p> <p>D.2 <i>Arctic-alpine heathlands</i>. Natural heathlands and dwarf <i>Juniper</i> stands in areas too cold to support forest growth in high latitudes or elevations.</p> <p>D.3 <i>Garrigues and thorn-cushion communities</i>. Low scrubs from the Mediterranean and mountains of dry continental areas.</p>
E. Tall forb and ruderal communities	<p>E.1 <i>Tall forb communities</i>. Tall-herb vegetation in naturally nutrient-rich habitats in mountains and forest-fringes.</p> <p>E.2 <i>Ruderal communities</i>. Vegetation growing on nitrified places, mostly anthropogenic. Segetal communities are not included.</p>
F. Deserts and semi-deserts	<p>F.1 <i>Alpine deserts</i>. Sparse climatogenic vegetation in the alpine belt of arid mountains.</p> <p>F.2 <i>Cold deserts and semi-deserts</i>. Sparse vegetation in arid regions with frost.</p> <p>F.3 <i>Warm deserts and semi-deserts</i>. Sparse vegetation in arid regions without frost.</p>

Table S2.3. Assignment rules for phytosociological syntaxa to the 22 fine-level vegetation types. Classes occurring in Europe are named after Mucina et al. (2016), classes not occurring in Europe according to various sources (Mirkin et al., 1992; Ermakov & Krestov, 2009; Akhiani et al., 2013; Noroozi et al., 2014; Nowak et al., 2018).

Class	Order	Alliance	Fine-level vegetation type
<i>Adiantetetea</i>			C.2 Rocks and screes
<i>Ajanio-Cleistogenetea songoricae</i>	<i>Ajanio-Cleistogenetalia songoricae</i>	<i>Ajanio-Cleistogenenion songoricae</i>	F.1 Alpine deserts
<i>Ajanio-Cleistogenetea songoricae</i>	<i>Ajanio-Cleistogenetalia songoricae</i>	<i>Piptathero gracilis-Artemision brevifoliae</i>	F.2 Cold deserts and semi-deserts
<i>Ammophiletea</i>			C.1 Dunes
<i>Artemisietea lerchiana</i>			F.2 Cold deserts and semi-deserts
<i>Artemisietea vulgaris</i>			E.2 Ruderal communities
<i>Arundinello anomalae-Agrostietea trinii</i>			B.3 Mesic grasslands
<i>Asplenetetea trichomanis</i>			C.2 Rocks and screes
<i>Astragalo microcephali-Brometea tomentelli</i>	<i>Astragalo microcephali-Brometalia tomentelli</i>		D.3 Garrigues and thorn cushion communities
<i>Astragalo microcephali-Brometea tomentelli</i>	<i>Onobrychido armenae-Thymetalia leucostomi</i>		D.3 Garrigues and thorn cushion communities
<i>Astragalo microcephali-Brometea tomentelli</i>	<i>Carici stenophylloidis-Stipetalia arabicae</i>		A.3 Xeric grasslands and steppes
<i>Bidentetetea</i>			E.2 Ruderal communities
<i>Cakiletea maritimae</i>			C.1 Dunes
<i>Calamagrostietea langsdorfii</i>			B.4 Wet grasslands
<i>Calluno-Ulicetea</i>			D.1 Lowland heathlands
<i>Carici rupestris-Kobresietea bellardii</i>			A.1 Alpine grasslands
<i>Chenopodietea</i>			E.2 Ruderal communities
<i>Cleistogenetea squarrosae</i>	<i>Festucetalia lenensis</i>		A.3 Xeric grasslands and steppes
<i>Cleistogenetea squarrosae</i>	<i>Stipetalia krylovii</i>		A.2 Alpine steppes
<i>Crithmo-Staticetea</i>			C.3 Saline communities
<i>Cymbalario-Parietarietea diffusae</i>			C.2 Rocks and screes
<i>Didymophyso aucheri-Dracocephaletea aucheri</i>			C.2 Rocks and screes
<i>Digitario sanguinalis-Eragrostietea minoris</i>			E.2 Ruderal communities
<i>Elyno-Seslerietea</i>			A.1 Alpine grasslands
<i>Epilobietea angustifolii</i>			E.2 Ruderal communities
<i>Festucetea indigestae</i>	<i>Festucetalia indigestae</i>		A.1 Alpine grasslands
<i>Festucetea indigestae</i>	<i>Jasiono sessiliflorae-Koelerietalia crassipedis</i>		B.1 Sandy dry grasslands

<i>Festuco hystricis-Ononidetea striatae</i>	<i>Erysimo-Jurineetalia bocconeii</i>	<i>Cytiso spinescentis-Bromion erecti</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Erysimo-Jurineetalia bocconeii</i>	<i>Seslerio nitidae-Caricion macrolepidis</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Erysimo-Jurineetalia bocconeii</i>	<i>Alyssion bertolonii</i>	D.3 Garrigues and thorn cushion communities
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Erysimo-Jurineetalia bocconeii</i>	<i>Cytiso spinescentis-Saturejion montanae</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Erysimo-Jurineetalia bocconeii</i>	<i>Cerastio-Astragalion nebrodensis</i>	D.3 Garrigues and thorn cushion communities
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Festuco hystricis-Poetalia ligulatae</i>		A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Ononidetalia striatae</i>	<i>Festucion scopariae</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Ononidetalia striatae</i>	<i>Genistion occidentalis</i>	D.3 Garrigues and thorn cushion communities
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Ononidetalia striatae</i>	<i>Ononidion striatae</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Ononidetalia striatae</i>	<i>Ononidion cristatae</i>	A.4 Rocky grasslands
<i>Festuco hystricis-Ononidetea striatae</i>	<i>Ononidetalia striatae</i>	<i>Genistion lobelii</i>	D.3 Garrigues and thorn cushion communities
<i>Festuco-Brometea</i>	<i>Artemisio albae-Brometalia erecti</i>	<i>Xerobromion erecti</i>	A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Astragalo onobrychidis-Potentilletalia</i>		A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Brachypodietalia phoenicoidis</i>	<i>Brachypodion phoenicoidis</i>	B.2 Meso-xeric grasslands
<i>Festuco-Brometea</i>	<i>Brachypodietalia phoenicoidis</i>	<i>Diplachnion serotinae</i>	A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Brachypodietalia pinnati</i>		B.2 Meso-xeric grasslands
<i>Festuco-Brometea</i>	<i>Festucetalia valesiaca</i>		A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Helictotricho desertorum-Stipetalia</i>		A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Scorzoneretalia villosae</i>	<i>Hippocrepido glaucae-Stipion austroitalicae</i>	A.4 Rocky grasslands
<i>Festuco-Brometea</i>	<i>Scorzoneretalia villosae</i>	<i>Saturejion subspicatae</i>	A.4 Rocky grasslands
<i>Festuco-Brometea</i>	<i>Scorzoneretalia villosae</i>	<i>Scorzonerion villosae</i>	B.2 Meso-xeric grasslands
<i>Festuco-Brometea</i>	<i>Stipetalia sibiricae</i>	<i>Aconito barbati-Poion transbaicalicae</i>	B.2 Meso-xeric grasslands
<i>Festuco-Brometea</i>	<i>Stipetalia sibiricae</i>	<i>Veronico incanae-Helictotrichion</i>	A.3 Xeric grasslands and steppes
<i>Festuco-Brometea</i>	<i>Stipo pulcherrimae-Festucetalia pallentis</i>		A.4 Rocky grasslands
<i>Festuco-Brometea</i>	<i>Thymo cretacei-Hyssopetalia cretacei</i>		A.4 Rocky grasslands
<i>Festuco-Puccinellietea</i>			C.4 Saline steppes and semi-deserts

<i>Helianthemetea guttati</i>			B.5 Mediterranean grasslands
<i>Helianthemo-Thymetea</i>			A.4 Rocky grasslands
<i>Helichryso-Crucianelletea maritimae</i>			C.1 Dunes
<i>Isoëto-Nanojuncetea</i>			C.5 Wetlands
<i>Juncetea maritimi</i>			C.3 Saline communities
<i>Juncetea trifidi</i>	<i>Caricetalia curvulae</i>		A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Viola altaicae-</i> <i>Festucetalia krylovianae</i>		A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Festucetalia spadiceae</i>	<i>Agrostion schraderianae</i>	A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Festucetalia spadiceae</i>	<i>Carici macrostylidi-Nardion</i>	A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Festucetalia spadiceae</i>	<i>Festucion variae</i>	A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Festucetalia spadiceae</i>	<i>Nardion strictae</i>	A.1 Alpine grasslands
<i>Juncetea trifidi</i>	<i>Festucetalia spadiceae</i>	<i>Festucion eskiae</i>	B.3 Mesic grasslands
<i>Juncetea trifidi</i>	<i>Juncetalia trifidi</i>		A.1 Alpine grasslands
<i>Kleinio-Euphorbietea canariensis</i>	<i>Kleinio-Euphorbietalia canariensis</i>		F.3 Warm deserts and semi-deserts
<i>Koelerio-Corynepherea canescentis</i>			B.1 Sandy dry grasslands
<i>Littorelletea uniflorae</i>			C.5 Wetlands
<i>Loiseleurio procumbentis-Vaccinieta</i>			D.2 Arctic-alpine heathlands
<i>Lygeo sparti-Stipetea tenacissimae</i>			B.5 Mediterranean grasslands
<i>Molinio-Arrhenatheretea</i>	<i>Arrhenatheretalia elatioris</i>		B.3 Mesic grasslands
<i>Molinio-Arrhenatheretea</i>	<i>Filipendulo ulmariae-Lotetalia uliginosi</i>		E.1 Tall forb communities
<i>Molinio-Arrhenatheretea</i>	<i>Holoschoenetalia</i>		B.4 Wet grasslands
<i>Molinio-Arrhenatheretea</i>	<i>Molinietalia caeruleae</i>		B.4 Wet grasslands
<i>Molinio-Arrhenatheretea</i>	<i>Poo alpinae-Trisetetalia</i>		B.3 Mesic grasslands
<i>Molinio-Arrhenatheretea</i>	<i>Potentillo-Polygonetalia avicularis</i>		B.4 Wet grasslands
<i>Montio-Cardaminetea</i>			C.5 Wetlands
<i>Mulgedio-Aconitetea</i>			E.1 Tall forb communities
<i>Nardetea strictae</i>	<i>Nardetalia strictae</i>	<i>Nardo-Agrostion tenuis</i>	B.3 Mesic grasslands
<i>Nardetea strictae</i>	<i>Nardetalia strictae</i>	<i>Nardo-Juncion squarrosi</i>	B.4 Wet grasslands
<i>Nardetea strictae</i>	<i>Nardetalia strictae</i>	<i>Violion caninae</i>	B.3 Mesic grasslands
<i>Onobrychidetea cornutae</i>			D.3 Garrigues and thorn cushion communities
<i>Ononido-Rosmarinetea</i>			D.3 Garrigues and thorn cushion communities
<i>Oxycocco-Sphagnetetea</i>			C.5 Wetlands
<i>Oxytropidetea persicae</i>			D.2 Arctic-alpine heathlands
<i>Papaveretea rhoeadis</i>			E.2 Ruderal communities
<i>Pegano harmalae-Salsoletea vermiculatae</i>			F.2 Cold deserts and semi-deserts
<i>Phragmito-Magnocaricetea</i>			C.5 Wetlands

<i>Poetea bulbosae</i>	B.5 Mediterranean grasslands
<i>Polygono-Poetea annuae</i>	E.2 Ruderal communities
<i>Polypodietea</i>	C.2 Rocks and screes
<i>Prangetea ulopterae</i>	E.1 Tall forb communities
<i>Rhododendro hirsuti-Ericetea carneae</i>	D.2 Arctic-alpine heathlands
<i>Rumici-Astragaletea siculi</i>	D.3 Garrigues and thorn cushion communities
<i>Saginetea maritimae</i>	C.3 Saline communities
<i>Salicetea herbaceae</i>	D.2 Arctic-alpine heathlands
<i>Salicornietea fruticosae</i>	C.3 Saline communities
<i>Scheuchzerio palustris-Caricetea fuscae</i>	C.5 Wetlands
<i>Sedo-Scleranthetea</i>	A.4 Rocky grasslands
<i>Sisymbrietea</i>	E.2 Ruderal communities
<i>Spartinetea maritimae</i>	C.3 Saline communities
<i>Stipo giganteae-Agrostietea castellanae</i>	B.5 Mediterranean grasslands
<i>Stipo-Trachynietea distachyae</i>	B.5 Mediterranean grasslands
<i>Therosalicornietea</i>	C.3 Saline communities
<i>Thlaspietea rotundifolii</i>	C.2 Rocks and screes
<i>Trifolio-Geranietea sanguinei</i>	E.1 Tall forb communities



Figure S2.1. Distribution of plots in the dataset across coarse- and fine-level vegetation types. A dynamic version including percentage numbers for each vegetation type is provided in the GrassPlot Explorer, panel *Vegetation types*.

References

- Akhani, H., Noroozi, J. & Mahdavi, P. (2013) Vegetation patterns of the Irano-Turanian steppe along a 3,000 m altitudinal gradient in the Alborz Mountains of northern Iran. *Folia Geobotanica*, 48, 229–255. <https://doi.org/10.1007/s12224-012-9147-8>
- Dengler, J., Biurrun, I., Boch, S., Dembiczy, I. & Török, P. (2020) Grasslands of the Palaearctic biogeographic realm: introduction and synthesis. In: Goldstein, M.I. and DellaSala, D.A. (Eds.), *Encyclopedia of the world's biomes*. Amsterdam: Elsevier, pp. 617–637.
- Ermakov, N. & Krestov, P. (2009) *Revision of the higher syntaxa of meadows in the Russian far east*. Vegetation of Russia 14. St. Petersburg.
- Mirkin, B. M., Kononov, K. E., Gogoleva, P. A., Burtserva, E. I. & Naumova, L. G. (1992) The floodplain grasslands of the Middle Lena-river II. Classification. *Folia Geobotanica et Phytotaxonomica*, 27, 247–300. <https://doi.org/10.1007/BF02853018>
- Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J.-P., Raus, T., Čarni, A. et al. (2016) Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science*, 19, 2–264. <https://doi.org/10.1111/avsc.12257>
- Noroozi, J., Willner, W., Pauli, H. & Grabherr, G. (2014) Phytosociology and ecology of the high-alpine to subnival scree vegetation of N and NW Iran (Alborz and Azerbaijan Mts.). *Applied Vegetation Science*, 17, 142–161. <https://doi.org/10.1111/avsc.12031>
- Nowak, A., Nobis, A., Nowak, S. & Nobis, M. (2018) Classification of steppe vegetation in the eastern Pamir Alai and southwestern Tian-Shan Mountains (Tajikistan, Kyrgyzstan). *Phytocoenologia*, 48, 369–391. <https://doi.org/10.1127/phyto/2018/0237>