Supplementary materials: Testing the contribution of multi-source remote sensing features for random forest classification of the Greater Amanzule tropical peatland

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Table S1. Confusion matrix for land cover classification of S2 dataset (original Sentinel-2 image bands).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	226	36	0	0	0	0	2	0	0	0	0	1
Mixed swamp	0	586	0	0	2	0	1	0	0	0	0	0
Palm swamp	0	1	331	0	0	0	2	0	0	0	0	0
Bog plain	0	0	0	264	0	0	0	0	0	4	1	0
Natural forest	0	1	1	0	110	0	0	3	0	0	0	0
Sparse vegetation	0	0	0	2	7	197	12	1	7	16	0	0
Coconut	1	36	5	16	37	7	171	7	0	2	0	0
Rubber	0	0	0	0	23	6	0	198	1	0	0	0
Oil palm	0	0	0	0	2	1	5	1	61	0	0	0
Built-up	0	0	0	13	0	2	0	0	0	227	4	12
Bare surface	0	0	0	4	0	1	0	0	0	10	157	0
Water	0	0	0	0	0	0	0	0	0	0	0	87

Table S2. Confusion matrix for land cover classification of S2+ dataset (original Sentinel-2 bands plus further spectral features – principally VIs – extracted from the Sentinel-2 bands).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	242	21	0	0	0	0	1	0	0	0	0	1
Mixed swamp	0	586	0	0	1	0	2	0	0	0	0	0
Palm swamp	0	2	330	0	0	0	1	1	0	0	0	0
Bog plain	0	0	1	263	0	0	0	0	0	4	0	1
Natural forest	0	0	1	0	111	0	1	2	0	0	0	0
Sparse vegetation	0	0	0	0	4	201	14	4	5	14	0	0
Coconut	0	29	3	12	38	4	183	9	1	3	0	0
Rubber	0	0	0	0	21	6	0	201	0	0	0	0
Oil palm	0	0	0	0	3	0	2	1	64	0	0	0
Built-up	0	0	0	8	0	4	2	0	0	226	0	18
Bare surface	0	0	0	5	0	0	0	0	0	11	156	0
Water	0	0	0	0	0	0	0	0	0	0	0	87

Table S3. Confusion matrix for land cover classification of S1 dataset (original Sentinel-1 image bands).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	198	24	9	1	20	0	12	1	0	0	0	0
Mixed swamp	38	434	9	0	90	0	11	6	0	1	0	0
Palm swamp	5	4	307	0	4	0	6	0	5	3	0	0
Bog plain	0	0	0	262	3	0	0	0	0	4	0	0
Natural forest	0	8	0	1	104	0	0	2	0	0	0	0
Sparse vegetation	0	3	0	1	140	88	1	5	0	4	0	0
Coconut	15	35	16	2	68	0	132	4	3	7	0	0
Rubber	1	11	0	0	70	0	1	145	0	0	0	0
Oil palm	0	0	18	0	0	0	2	0	45	5	0	0
Built-up	10	8	2	31	45	1	3	2	7	150	3	0
Bare surface	0	0	0	28	7	0	0	1	0	10	127	0
Water	0	0	0	10	0	0	0	0	0	0	0	77

Table S4. Confusion matrix for land cover classification of S1+ dataset (original Sentinel-1 bands plus further texture and temporal features extracted from the Sentinel-1 bands).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	192	34	1	0	28	0	3	1	0	6	0	0
Mixed swamp	22	502	4	0	38	0	15	5	3	0	0	0
Palm swamp	0	2	320	0	1	0	6	3	2	0	0	0
Bog plain	0	1	0	263	1	0	0	2	0	2	0	0
Natural forest	0	2	0	0	111	0	0	2	0	0	0	0
Sparse vegetation	1	15	5	5	43	109	2	57	5	0	0	0
Coconut	8	54	18	2	21	0	144	26	3	5	1	0
Rubber	3	26	1	0	21	0	2	174	0	1	0	0
Oil palm	0	1	9	0	2	0	1	1	55	1	0	0
Built-up	0	1	0	15	63	0	0	1	1	176	4	1
Bare surface	0	0	0	16	2	0	0	0	0	9	145	1
Water	0	0	0	0	3	0	0	0	0	0	0	84

Table S5. Confusion matrix for land cover classification of S2+S1+ dataset (original Sentinel-2 and Sentinel-1 bands plus further features extracted from the Sentinel-2 and Sentinel-1 bands).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	245	17	0	0	0	0	2	0	0	0	0	1
Mixed swamp	0	586	0	0	1	0	2	0	0	0	0	0
Palm swamp	0	1	332	0	0	0	1	0	0	0	0	0
Bog plain	0	0	1	262	0	0	0	0	0	5	1	0
Natural forest	0	0	0	0	113	0	0	2	0	0	0	0
Sparse vegetation	0	3	0	0	4	220	11	0	0	4	0	0
Coconut	0	36	3	4	34	5	184	10	1	5	0	0
Rubber	0	0	0	0	16	5	2	205	0	0	0	0
Oil palm	0	0	0	0	2	0	1	1	66	0	0	0
Built-up	0	0	0	2	0	5	1	0	0	249	0	1
Bare surface	0	0	0	5	0	0	0	0	0	12	155	0
Water	0	0	0	0	0	0	0	0	0	0	0	87

Table S6. Confusion matrix for land cover classification of S2+S1+DEM dataset (original Sentinel-2 and Sentinel-1 bands plus further features extracted from the Sentinel-2 and Sentinel-1 bands, plus STRM-derived elevation features).

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Mangrove	255	8	0	0	0	0	1	0	0	0	0	1
Mixed swamp	0	587	0	0	0	0	2	0	0	0	0	0
Palm swamp	0	1	332	0	0	0	1	0	0	0	0	0
Bog plain	0	0	0	264	0	0	0	0	0	5	0	0
Natural forest	0	1	0	0	114	0	0	0	0	0	0	0
Sparse vegetation	0	0	0	0	3	220	12	3	0	4	0	0
Coconut	0	38	2	5	20	3	200	9	0	5	0	0
Rubber	0	1	0	0	4	5	1	217	0	0	0	0
Oil palm	0	0	0	0	1	0	1	1	67	0	0	0
Built-up	0	0	0	4	0	4	2	0	0	247	0	1
Bare surface	0	0	0	5	0	0	0	0	0	12	155	0
Water	0	0	0	0	0	0	0	0	0	0	0	87

Tables S7–11. Feature importance for discriminating various land cover types based on the different datasets: (a) S2 (original Sentinel-2 image bands), (b) S2+ (original Sentinel-2 bands plus further spectral features – principally VIs – extracted from the Sentinel-2 bands), (c) S1 (original Sentinel-1 image bands), (d) S1+ (original Sentinel-1 bands plus further texture and temporal features extracted from the Sentinel-1 bands), and (e) S2+S1+ (original Sentinel-2 and Sentinel-1 bands plus further features extracted from the Sentinel-2 and Sentinel-1 bands). The five most important features are denoted with the letters a, b, c, d and e respectively. (ARVI = atmospherically resistant vegetation index, EVI = enhanced vegetation index, GNDVI = green normalized difference vegetation index, LSWI = land surface water index, MSAVI2 = modified soil-adjusted vegetation index, NBR = normalized burn ratio, NBR2 = normalized burn ratio 2, NDVI = normalized difference vegetation index, NDWI = normalized difference water index, NIR = near infrared, stdDev = standard deviation, SWIR = shortwave infrared, S2REP = Sentinel-2 red edge position index, VH = Sentinel-1 vertical-horizontal cross polarization, VV = Sentinel-1 vertical-vertical co-polarization.)

Table S7. Feature importance for discriminating various land cover types based on the S2 dataset.

	Mangrove	**Mixed swamp**	**Palm swamp**	**Bog plain**	**Natural forest**	**Sparse vegetation**	**Coconut**	**Rubber**	**Oil palm**	**Built-up**	**Bare surface**	**Water**
Blue	0.0024	0.0015	0.0153	0.0777	0.0305	0.0113	0.0077	0.0082	0.0138	0.2995e	0.2189	0.0152
Green	0.0499	0.0533e	0.0991d	0.1472d	0.0028	0.0925	0.0449	0.0304	0.0576	0.4022d	0.3949d	0.0154
Red	0.0271	0.0364	0.0714	0.2943b	0.0246	0.0868	0.0298	0.0160	0.0403	0.7645a	1.1068a	0.0899c
Red Edge 1	0.0552d	0.0507	0.0824	0.1247e	0.0299	0.0884	0.0483	0.0402	0.0596	0.2194	0.34904	0.0046
Red Edge 2	0.0386	0.0348	0.0516	0.0337	0.0460	0.0636	0.0457	0.0532	0.0573	0.0363	0.0806	0.0362
Red Edge 3	0.0571c	0.0556d	0.0785	0.0459	0.0836d	0.1026e	0.0776d	0.0907e	0.0977d	0.0435	0.1043	0.0616
NIR	0.0783b	0.0780c	0.1074c	0.0656	0.1170c	0.1429d	0.1071c	0.1238c	0.1340c	0.0584	0.1244	0.0880d
Red Edge 4	0.0892a	0.0917b	0.1237b	0.0786	0.1335b	0.1617c	0.1237b	0.1417b	0.1533b	0.0679	0.1286	0.1033b
SWIR1	0.0508e	0.1000a	0.1908a	0.3159a	0.1478a	0.2868a	0.1345a	0.2147a	0.1859a	0.4884c	0.7082b	0.1562a
SWIR2	0.0079	0.0489	0.0946e	0.2797c	0.0645e	0.1776b	0.0571e	0.1060d	0.0851e	0.6602b	0.6738c	0.0860e

Table S8. Feature importance for discriminating various land cover types based on the S2+ dataset.

	Mangrove	Mixed swamp	Palm swamp	Bog plain	Natural forest	Sparse vegetation	Coconut	Rubber	Oil palm	Built-up	Bare surface	Water
Blue	0.0016	0.0009	0.0000	0.0474	0.0188	0.0087	0.0050	0.0049	0.0087	0.1819	0.1360	0.0093
Green	0.0276	0.0295	0.0543	0.0811e	0.0017	0.0527	0.0248	0.0173	0.0314	0.2200e	0.2189	0.0086
Red	0.0144	0.0192	0.0375	0.1551a	0.0129	0.0483	0.0155	0.0087	0.0211	0.4005a	0.5858a	0.0476
Red Edge 1	0.0237	0.0220	0.0353	0.0538	0.0130	0.0386	0.0210	0.0174	0.0256	0.0940	0.1501	0.0019
Red Edge 2	0.0217	0.0198	0.0291	0.0191	0.0263	0.0366	0.0261	0.0304	0.0323	0.0205	0.0453	0.0205
Red Edge 3	0.0259	0.0255	0.0356	0.0210	0.0383	0.0476	0.0356	0.0417	0.0444	0.0197	0.0472	0.0280
NIR	0.0208	0.0210	0.0286	0.0176	0.0315	0.0391	0.0289	0.0335	0.0357	0.0155	0.0331	0.0235
Red Edge 4	0.0184	0.0191	0.0255	0.0163	0.0278	0.0341	0.0258	0.0296	0.0317	0.0140	0.0264	0.0214
SWIR1	0.0208	0.0415e	0.0785c	0.1302c	0.0613e	0.1212b	0.0556e	0.0895	0.0763e	0.2010	0.2947b	0.0643d
SWIR2	0.0028	0.0168	0.0322	0.0952d	0.0222	0.0622	0.0194	0.0366	0.0289	0.2247d	0.2302e	0.0293
NDVI	0.1052a	0.1037a	0.1089a	0.0548	0.1294b	0.1188c	0.1160b	0.1249	0.1239b	0.0101	0.0050	0.0949a
NDVI stdDev	0.0499d	0.0013	0.0046	0.0167	0.0023	0.0101	0.0024	0.0002	0.0021	0.0343	0.1024	0.0100
NDWI	0.1033b	0.1026b	0.1087b	0.0796	0.1301a	0.1249a	0.1180a	0.1283	0.1274a	0.0354	0.0722	0.0808b
EVI	0.0459e	0.0456d	0.0606e	0.0177	0.0747d	0.0832e	0.0643d	0.0759	0.0793d	0.0233	0.0101	0.0613e
MSAVI2	0.0606c	0.0598c	0.0765d	0.0204	0.0974c	0.1019d	0.0826c	0.0970	0.0999c	0.0317	0.0201	0.0774c
LSWI	0.0369	0.0084	0.0118	0.1487b	0.0212	0.0199	0.0162	0.0047	0.0190	0.2867b	0.2464d	0.0399
ARVI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NBR	0.0390	0.0253	0.0206	0.0673	0.0334	0.0104	0.0312	0.0238	0.0329	0.2286c	0.1300	0.0089
NBR2	0.0272	0.0239	0.0279	0.0130	0.0286	0.0258	0.0289	0.0292	0.0299	0.0109	0.0204	0.0166
GNDVI	0.0109	0.0073	0.0108	0.0767	0.0169	0.0009	0.0067	0.0069	0.0070	0.1262	0.2529c	0.0493
S2REP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table S9. Feature importance for discriminating various land cover types based on the S1 dataset.

	Mangrove	Mixed swamp	Palm swamp	Bog plain	Natural forest	Sparse vegetation	Coconut	Rubber	Oil palm	Built-up	Bare surface	Water
VH	0.5737b	0.5775b	0.4974b	0.2387a	0.5504b	0.5014b	0.5265b	0.5259b	0.4619b	0.4497b	0.1222b	0.2300b
VV	0.6865a	0.6534a	0.6091a	0.1091b	0.5991a	0.5108a	0.6050a	0.5456a	0.5762a	0.5243a	0.1354a	0.4029a

Table S10. Feature importance for discriminating various land cover types based on the S1+ dataset.

	Mangrove	Mixed swamp	Palm swamp	Bog plain	Natural forest	Sparse vegetation	Coconut	Rubber	Oil palm	Built-up	Bare surface	Water
VH	0.2478a	0.2495a	0.2145a	0.1032a	0.2374a	0.2174a	0.2273a	0.2279a	0.1998a	0.1949c	0.0449	0.0991b
VV	0.1963b	0.1866b	0.1730b	0.0307b	0.1705b	0.1457b	0.1724b	0.1565b	0.1637b	0.1495e	0.0351	0.1147a
VH stdDev	0.1279c	0.1431c	0.0650c	0.0195c	0.1426c	0.0922c	0.0941c	0.0983c	0.0587c	0.1066	0.0480e	0.0805c
VV stdDev	0.0707e	0.0644e	0.0436e	0.0034	0.0619	0.0319e	0.0470e	0.0380e	0.0394e	0.1035	0.0069	0.0386e
VV variance	0.0109	0.0046	0.0173	0.0047	0.0556	0.0035	0.0094	0.0084	0.0127	0.2045b	0.0733d	0.0179
VV contrast	0.0161	0.0103	0.0232	0.0060e	0.0802e	0.0036	0.0126	0.0083	0.0171	0.3046a	0.1030c	0.0242
VV correlation	0.0064	0.0001	0.0054	0.0052	0.0081	0.0074	0.0054	0.0170	0.0039	0.0047	0.0115	0.0086
VH variance	0.0027	0.0018	0.0178	0.0003	0.0369	0.0120	0.0114	0.0001	0.0149	0.1036	0.1431b	0.0122
VH contrast	0.0030	0.0011	0.0270	0.0032	0.0547	0.0188	0.0179	0.0042	0.0228	0.1618d	0.1981a	0.0168
VH correlation	0.0064	0.0018	0.0027	0.0135d	0.0100	0.0093	0.0061	0.0192	0.0047	0.0065	0.0224	0.0085
$VV_{\Delta amplitude}$	0.0697	0.0624	0.0436	0.0044	0.0592	0.0314	0.0467	0.0378	0.0390	0.0949	0.0123	0.0362
$VH_{\Delta amplitude}$	0.1062d	0.1173d	0.0545d	0.0034	0.1144d	0.0783d	0.0780d	0.0811d	0.0488d	0.0772	0.0405	0.0656d

Table S11. Feature importance for discriminating various land cover types based on the S2+S1+ dataset.

	Mangrove	Mixed swamp	Palm swamp	Bog plain	Natural forest	Sparse vegetation	Coconut	Rubber	Oil palm	Built-up	Bare surface	Water
Blue	0.0016	0.0009	0.0074	0.0377	0.0146	0.0065	0.0036	0.0036	0.0069	0.1434	0.1100	0.0072
Green	0.0218	0.0235	0.0437e	0.0650d	0.0014	0.0413	0.0203	0.0137	0.0247	0.1758e	0.1799e	0.0067
Red	0.0118	0.0169	0.0332	0.1369a	0.0113	0.0432	0.0146	0.0077	0.0179	0.3518a	0.5289a	0.0415d
Red Edge 1	0.0216	0.0200	0.0325	0.0492	0.0118	0.0351	0.0195	0.0158	0.0231	0.0857	0.1412	0.0018
Red Edge 2	0.0108	0.0097	0.0144	0.0094	0.0128	0.0175	0.0129	0.0148	0.0158	0.0100	0.0230	0.0101
Red Edge 3	0.0044	0.0043	0.0060	0.0035	0.0064	0.0078	0.0060	0.0070	0.0075	0.0033	0.0082	0.0047
NIR	0.0085	0.0085	0.0117	0.0071	0.0128	0.0155	0.0118	0.0135	0.0145	0.0063	0.0140	0.0096
Red Edge 4	0.0058	0.0059	0.0079	0.0050	0.0085	0.0103	0.0080	0.0091	0.0098	0.0043	0.0085	0.0066
SWIR1	0.0095	0.0189	0.0362	0.0598e	0.0279	0.0553e	0.0260	0.0408	0.0348	0.0923	0.1376	0.0296
SWIR2	0.0024	0.0157	0.0305	0.0902c	0.0207	0.0595d	0.0191	0.0344	0.0269	0.2119c	0.2249b	0.0277
NDVI	0.0620c	0.0606c	0.0639c	0.0319	0.0756c	0.0685c	0.0679b	0.0730c	0.0727c	0.0061	0.0031	0.0556a
NDVI stdDev	0.0349	0.0009	0.0029	0.0119	0.0016	0.0087	0.0019	0.0000	0.0016	0.0232	0.0683	0.0069
VH	0.1102	0.1108a	0.0954a	0.0457	0.1056a	0.0964a	0.1009a	0.1014a	0.0887a	0.0866	0.0225	0.0441c
VV	0.0645a	0.0614	0.0571d	0.0102	0.0562	0.0479	0.0567d	0.0517d	0.0541d	0.0491	0.0122	0.0377
VH stdDev	0.0613b	0.0692b	0.0317	0.0093	0.0694d	0.0456	0.0454e	0.0480e	0.0282	0.0515	0.0210	0.0391e
VV stdDev	0.0362	0.0335	0.0228	0.0016	0.0324	0.0176	0.0247	0.0200	0.0205	0.0552	0.0033	0.0201
NDWI	0.0612d	0.0605d	0.0642b	0.0468	0.0766b	0.0728b	0.0697c	0.0756b	0.0753b	0.0207	0.0430	0.0478b
EVI	0.0237	0.0232	0.0311	0.0089	0.0379	0.0410	0.0330	0.0385	0.0405	0.0120	0.0049	0.0313
MSAVI2	0.0251	0.0244	0.0314	0.0082	0.0395	0.0403	0.0338	0.0394	0.0409e	0.0131	0.0081	0.0317
LSWI	0.0318	0.0072	0.0097	0.1260b	0.0178	0.0210	0.0129	0.0041	0.0164	0.2432b	0.2033c	0.0337
ARVI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NBR	0.0327	0.0210	0.0171	0.0564	0.0276	0.0060	0.0252	0.0196	0.0275	0.1903d	0.1088	0.0074
NBR2	0.0267	0.0232	0.0273	0.0125	0.0279	0.0245	0.0280	0.0284	0.0292	0.0107	0.0193	0.0162
VV variance	0.0008	0.0009	0.0037	0.0009	0.0118	0.0006	0.0020	0.0016	0.0030	0.0427	0.0162	0.0038
VV contrast	0.0016	0.0023	0.0054	0.0012	0.0186	0.0006	0.0029	0.0017	0.0044	0.0695	0.0252	0.0056
VV correlation	0.0003	0.0000	0.0004	0.0004	0.0006	0.0006	0.0004	0.0013	0.0002	0.0004	0.0009	0.0006
VH variance	0.0005	0.0004	0.0041	0.0000	0.0086	0.0027	0.0026	0.0002	0.0036	0.0234	0.0350	0.0028

VH contrast	0.0012	0.0003	0.0080	0.0007	0.0164	0.0053	0.0053	0.0015	0.0070	0.0467	0.0616	0.0050
VH correlation	0.0003	0.0001	0.0001	0.0008	0.0006	0.0006	0.0004	0.0011	0.0002	0.0004	0.0014	0.0005
GNDVI	0.0084	0.0052	0.0079	0.0550	0.0120	0.0018	0.0044	0.0048	0.0053	0.0899	0.1826d	0.0352
$VV_{\Delta amplitude}$	0.0311	0.0280	0.0197	0.0018	0.0268	0.0152	0.0211	0.0172	0.0177	0.0437	0.0054	0.0164
$VH_{\Delta amplitude}$	0.0490e	0.0546e	0.0256	0.0013	0.0537e	0.0361	0.0362	0.0380	0.0225	0.0361	0.0177	0.0306
S2REP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000