

**Table S1.** The training sample.

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>
y1984_0830_LT05_173028	515203	y2000_1005_LE07_173028	394053
y1984_1204_LT05_173028	647871	y2001_0125_LE07_173028	789625
y1985_0801_LT05_173028	302462	y2001_0704_LE07_173028	115428
y1985_0817_LT05_173028	478759	y2001_0805_LE07_173028	448410
y1985_1105_LT05_173028	606175	y2001_1008_LE07_173028	406769
y1986_0329_LT05_173028	1115976	y2002_0317_LE07_173028	788885
y1986_0516_LT05_173028	623748	y2002_0621_LE07_173028	151394
y1986_0804_LT05_173028	762378	y2002_0824_LE07_173028	667864
y1986_1210_LT05_173028	672786	y2003_0803_LT05_173028	167065
y1987_0807_LT05_173028	204001	y2003_0920_LT05_173028	444860
y1987_1010_LT05_173028	408267	y2005_0520_LT05_173028	366019
y1988_0419_LT05_173028	737291	y2005_0808_LT05_173028	434812
y1988_0505_LT05_173028	502284	y2005_0909_LT05_173028	769690
y1988_0630_LT04_173028	77788	y2006_0710_LT05_173028	93377
y1988_0801_LT04_173028	165918	y2006_0827_LT05_173028	560202
y1988_0817_LT04_173028	344229	y2006_0912_LT05_173028	623733
y1988_0825_LT05_173028	469453	y2006_0928_LT05_173028	605625
y1988_1012_LT05_173028	310373	y2007_0713_LT05_173028	215718
y1989_0422_LT05_173028	659985	y2007_0830_LT05_173028	683794
y1989_0609_LT05_173028	302057	y2007_1001_LT05_173028	503136
y1989_0719_LT04_173028	176951	y2009_0702_LT05_173028	64206
y1989_0812_LT05_173028	422892	y2009_0803_LT05_173028	237518
y1989_0820_LT04_173028	355901	y2009_0819_LT05_173028	389931
y1989_0828_LT05_173028	509445	y2010_0806_LT05_173028	252068
y1989_1015_LT05_173028	447960	y2010_0822_LT05_173028	434552
y1990_0831_LT05_173028	745926	y2010_1025_LT05_173028	1100678
y1990_0916_LT05_173028	652737	y2011_0606_LT05_173028	148949
y1990_1103_LT05_173028	580623	y2011_0926_LT05_173028	673893
y1991_0818_LT05_173028	688539	y2013_0424_LC08_173028	505130
y1991_1021_LT05_173028	504520	y2013_0814_LC08_173028	371129
y1992_0804_LT05_173028	207932	y2013_1102_LC08_173028	474526
y1992_0820_LT05_173028	378924	y2014_0222_LC08_173028	747110
y1992_0905_LT05_173028	511451	y2014_0326_LC08_173028	684615
y1993_0722_LT05_173028	96948	y2014_0427_LC08_173028	450561
y1993_0807_LT05_173028	196726	y2014_0630_LC08_173028	54157
y1993_0924_LT05_173028	421459	y2014_0716_LC08_173028	143277
y1995_0626_LT05_173028	175702	y2014_0801_LC08_173028	137262
y1995_1016_LT05_173028	691506	y2014_0817_LC08_173028	220190
y1996_0425_LT05_173028	726561	y2014_0918_LC08_173028	521814
y1996_0612_LT05_173028	63039	y2014_1121_LC08_173028	292116
y1996_0628_LT05_173028	85510	y2015_0225_LC08_173028	385476
y1996_0714_LT05_173028	116895	y2015_0414_LC08_173028	327414
y1996_0815_LT05_173028	246929	y2015_0804_LC08_173028	152206
y1996_1018_LT05_173028	289816	y2015_0820_LC08_173028	299324

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>
y1997_0514_LT05_173028	255890	y2016_0619_LC08_173028	75944
y1997_0818_LT05_173028	50484	y2016_0907_LC08_173028	356748
y1998_0720_LT05_173028	187899	y2016_1025_LC08_173028	436332
y1998_0805_LT05_173028	311252	y2017_0403_LC08_173028	534100
y1998_0821_LT05_173028	409940	y2017_0505_LC08_173028	318109
y1998_1024_LT05_173028	500542	y2017_0606_LC08_173028	49261
y1999_0605_LT05_173028	259250	y2017_0809_LC08_173028	266510
y1999_0707_LT05_173028	84066	y2017_0825_LC08_173028	345345
y1999_0715_LE07_173028	107754	y2017_0926_LC08_173028	462606
y1999_0731_LE07_173028	184936	y2018_0609_LC08_173028	36070
y1999_0808_LT05_173028	157635	y2018_0828_LC08_173028	434203
y1999_1003_LE07_173028	289239	y2018_0913_LC08_173028	542721
y1999_1214_LT05_173028	754609	y2018_0929_LC08_173028	680037
y2000_0607_LT05_173028	219765	y2019_0220_LC08_173028	450969
y2000_0615_LE07_173028	118673	y2019_0815_LC08_173028	305095
y2000_0717_LE07_173028	185563	y2019_0831_LC08_173028	328188
y2000_0810_LT05_173028	237565	y2019_0916_LC08_173028	350061

**Table S2.** The test sample and the result of machine learning.

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Predicted bare soil masks, pixels</b>	<b>Intersection over union</b>
y1984_0906_LT05_174027	646338	585940	0.90
y1984_0922_LT05_174027	474257	451482	0.80
y1985_0808_LT05_174027	468017	421513	0.86
y1986_0131_LT05_174027	1211973	1165583	0.86
y1986_0216_LT05_174027	1258080	1196380	0.90
y1986_0405_LT05_174027	1275118	1246699	0.92
y1986_0811_LT05_174027	981447	838681	0.85
y1986_1014_LT05_174027	1141970	1137616	0.87
y1986_1115_LT05_174027	1035549	1060231	0.90
y1987_0611_LT05_174027	723413	255127	0.35
y1987_0729_LT05_174027	208907	229354	0.84
y1988_0731_LT05_174027	225685	239052	0.80
y1988_0816_LT05_174027	458783	455464	0.88
y1988_0824_LT04_174027	607255	537058	0.87
y1988_0917_LT05_174027	737381	738071	0.90
y1989_0312_LT05_174027	911570	1294782	0.67
y1989_0429_LT05_174027	618213	663593	0.86
y1989_0515_LT05_174027	447226	502637	0.77
y1989_0819_LT05_174027	487104	570655	0.81
y1989_0827_LT04_174027	596535	537661	0.86
y1989_1022_LT05_174027	699079	633843	0.85

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Predicted bare soil masks, pixels</b>	<b>Intersection over union</b>
y1990_0227_LT05_174027	983572	1117045	0.84
y1990_0416_LT05_174027	804554	798424	0.88
y1990_0705_LT05_174027	174115	163713	0.80
y1991_0419_LT05_174027	1005809	1018903	0.91
y1991_0809_LT05_174027	791802	755339	0.92
y1991_0926_LT05_174027	565520	764782	0.66
y1991_1012_LT05_174027	830962	703532	0.82
y1992_0928_LT05_174027	578982	731708	0.72
y1992_1014_LT05_174027	759908	677852	0.75
y1993_0424_LT05_174027	1001537	1182822	0.77
y1993_0510_LT05_174027	699348	711599	0.92
y1993_1017_LT05_174027	440208	466062	0.83
y1994_0716_LT05_174027	209434	226905	0.89
y1994_0817_LT05_174027	512809	615394	0.80
y1994_0918_LT05_174027	683353	841695	0.79
y1994_1004_LT05_174027	726727	912962	0.76
y1995_0225_LT05_174027	941909	1681992	0.53
y1995_0601_LT05_174027	407431	438976	0.84
y1995_0617_LT05_174027	187824	219850	0.74
y1995_0804_LT05_174027	315552	339988	0.84
y1996_0416_LT05_174027	688558	1114322	0.60
y1996_0705_LT05_174027	141672	148898	0.89
y1996_0923_LT05_174027	449623	564679	0.71
y1996_1009_LT05_174027	513951	615397	0.65
y1996_1110_LT05_174027	618478	671215	0.78
y1997_0403_LT05_174027	945055	1145064	0.79
y1997_0521_LT05_174027	491446	465044	0.89
y1997_0708_LT05_174027	102044	110348	0.68
y1998_0727_LT05_174027	388576	373841	0.85
y1998_0828_LT05_174027	465978	557642	0.80
y1999_0425_LT05_174027	714883	787971	0.87
y1999_0807_LE07_174027	193697	273324	0.67
y1999_0831_LT05_174027	309494	490333	0.62
y1999_1111_LE07_174027	1166800	935588	0.76
y1999_1205_LT05_174027	896068	1094574	0.76
y2000_0302_LE07_174027	957050	1270358	0.72
y2000_0505_LE07_174027	468374	497592	0.87
y2000_0606_LE07_174027	287923	288992	0.82
y2000_0809_LE07_174027	292485	313689	0.86
y2001_0727_LE07_174027	362406	481172	0.71
y2001_0804_LT05_174027	579266	626432	0.84
y2001_0812_LE07_174027	732881	706660	0.90
y2002_0511_LE07_174027	579380	572933	0.94
y2002_0722_LT05_174027	334247	341031	0.90
y2003_0412_LE07_174027	658197	1109610	0.58

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Predicted bare soil masks, pixels</b>	<b>Intersection over union</b>
y2004_0524_LT05_174027	621013	561985	0.90
y2004_0828_LT05_174027	646813	659979	0.92
y2005_0730_LT05_174027	397898	427812	0.86
y2006_0919_LT05_174027	824259	728815	0.86
y2006_1106_LT05_174027	865656	861686	0.79
y2007_0517_LT05_174027	695978	669894	0.94
y2007_0720_LT05_174027	323400	404064	0.77
y2007_0805_LT05_174027	643981	661667	0.91
y2007_0821_LT05_174027	750454	782820	0.88
y2007_0906_LT05_174027	714666	903524	0.74
y2008_0519_LT05_174027	605157	603752	0.92
y2008_0620_LT05_174027	74263	78612	0.82
y2008_0722_LT05_174027	192564	189380	0.55
y2009_0709_LT05_174027	120974	115048	0.75
y2009_0725_LT05_174027	148628	210440	0.68
y2009_1013_LT05_174027	710933	693656	0.77
y2010_0610_LT05_174027	230252	234427	0.90
y2010_0712_LT05_174027	116806	127189	0.66
y2010_0728_LT05_174027	229158	248952	0.86
y2010_0829_LT05_174027	431382	555648	0.76
y2010_1117_LT05_174027	658859	865635	0.71
y2011_0528_LT05_174027	287297	348031	0.76
y2013_0501_LC08_174027	485436	392006	0.76
y2013_0720_LC08_174027	213882	181324	0.79
y2013_1024_LC08_174027	736110	792395	0.82
y2013_1109_LC08_174027	581741	647263	0.82
y2014_0605_LC08_174027	73056	89280	0.66
y2014_0723_LC08_174027	169471	148532	0.78
y2014_1011_LC08_174027	594626	594331	0.73
y2014_1027_LC08_174027	523209	691304	0.70
y2015_0523_LC08_174027	309788	274426	0.77
y2015_0608_LC08_174027	99070	100187	0.68
y2015_0726_LC08_174027	164199	132254	0.74
y2015_0811_LC08_174027	241647	236596	0.84
y2015_0827_LC08_174027	398400	383218	0.85
y2015_0928_LC08_174027	532148	509065	0.82
y2015_1217_LC08_174027	454298	535869	0.79
y2016_0407_LC08_174027	510260	461275	0.81
y2016_0829_LC08_174027	386849	410058	0.83
y2017_0309_LC08_174027	540570	718926	0.72
y2017_0426_LC08_174027	390228	387812	0.79
y2017_0512_LC08_174027	403091	369309	0.84
y2017_0917_LC08_174027	339377	464235	0.69
y2017_1120_LC08_174027	536280	568588	0.80
y2017_1222_LC08_174027	583724	650738	0.85

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Bare soil masks constructed manually, pixels</b>	<b>Predicted bare soil masks, pixels</b>	<b>Intersection over union</b>
y2018_0531_LC08_174027	75596	70869	0.71
y2018_0702_LC08_174027	155743	102627	0.59
y2018_0819_LC08_174027	554652	544879	0.89
y2018_0904_LC08_174027	534900	668916	0.74
y2018_0920_LC08_174027	731556	857894	0.78
y2018_1006_LC08_174027	976744	951163	0.79
y2019_0331_LC08_174027	495983	607258	0.76
y2019_0518_LC08_174027	106086	118745	0.64
y2019_0619_LC08_174027	33997	36854	0.83
y2019_0705_LC08_174027	70808	65694	0.73
y2019_0822_LC08_174027	377105	402114	0.82

**Table S3.** The acceptance sample.

<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Predicted bare soil masks, pixels</b>	<b>Landsat scene (year_month day_satellite_path row)</b>	<b>Predicted bare soil masks, pixels</b>
y1985_0817_LT05_173026	4129	y2002_0426_LT05_173026	1745
y1985_1105_LT05_173026	5414	y2002_0621_LE07_173026	472
y1986_0329_LT05_173026	6193	y2003_0507_LE07_173026	5689
y1986_0430_LT05_173026	5687	y2003_0523_LE07_173026	5109
y1986_0516_LT05_173026	0	y2004_0618_LT05_173026	3216
y1986_0601_LT05_173026	0	y2005_0808_LT05_173026	2899
y1986_1023_LT05_173026	6566	y2005_0909_LT05_173026	2487
y1987_0807_LT05_173026	3211	y2005_0925_LT05_173026	5138
y1987_1010_LT05_173026	1732	y2006_0827_LT05_173026	3861
y1987_1026_LT05_173026	1774	y2006_0912_LT05_173026	3705
y1988_0630_LT04_173026	3050	y2006_0928_LT05_173026	1276
y1988_0801_LT04_173026	1956	y2007_0526_LT05_173026	2518
y1988_0825_LT05_173026	3527	y2007_0713_LT05_173026	2663
y1988_1012_LT05_173026	1391	y2007_1001_LT05_173026	5636
y1988_1028_LT05_173026	1595	y2009_0702_LT05_173026	318
y1989_0321_LT05_173026	4335	y2010_0502_LT05_173026	5031
y1989_0406_LT05_173026	3495	y2010_0619_LT05_173026	0
y1989_0422_LT05_173026	1507	y2010_0806_LT05_173026	1304
y1989_0609_LT05_173026	0	y2010_0822_LT05_173026	1930
y1989_0719_LT04_173026	820	y2010_0923_LT05_173026	4027
y1989_0804_LT04_173026	1308	y2010_1025_LT05_173026	1805
y1989_0812_LT05_173026	2578	y2011_0419_LT05_173026	3301
y1989_0820_LT04_173026	2596	y2011_0606_LT05_173026	906
y1989_0828_LT05_173026	2560	y2011_0708_LT05_173026	899
y1989_1015_LT05_173026	2878	y2011_0809_LT05_173026	947
y1990_0324_LT05_173026	4204	y2013_0424_LC08_173026	3589
y1990_0714_LT05_173026	924	y2013_0611_LC08_173026	851
y1990_0815_LT05_173026	1029	y2013_0713_LC08_173026	900
y1991_0903_LT05_173026	2704	y2013_1102_LC08_173026	2769

Landsat scene (year_month day_satellite_path row)	Predicted bare soil masks, pixels	Landsat scene (year_month day_satellite_path row)	Predicted bare soil masks, pixels
y1991_1021_LT05_173026	2796	y2014_0427_LC08_173026	4679
y1992_0804_LT05_173026	1139	y2014_0630_LC08_173026	1607
y1992_0905_LT05_173026	1565	y2014_0801_LC08_173026	1580
y1993_0722_LT05_173026	0	y2014_0817_LC08_173026	1699
y1993_0807_LT05_173026	228	y2014_0902_LC08_173026	1676
y1993_0924_LT05_173026	659	y2014_0918_LC08_173026	1940
y1993_1111_LT05_173026	1525	y2014_1004_LC08_173026	1471
y1994_0404_LT05_173026	6953	y2014_1121_LC08_173026	3432
y1995_0525_LT05_173026	1593	y2015_0414_LC08_173026	3684
y1995_0610_LT05_173026	2484	y2015_0804_LC08_173026	3181
y1995_0626_LT05_173026	800	y2015_0905_LC08_173026	3170
y1995_0914_LT05_173026	1632	y2016_1025_LC08_173026	6494
y1995_1016_LT05_173026	5115	y2017_0403_LC08_173026	6865
y1996_0714_LT05_173026	921	y2017_0505_LC08_173026	6560
y1996_0815_LT05_173026	1981	y2017_0606_LC08_173026	2370
y1996_1018_LT05_173026	6359	y2017_0809_LC08_173026	0
y1997_0514_LT05_173026	2534	y2017_0910_LC08_173026	402
y1998_0501_LT05_173026	1927	y2018_0406_LC08_173026	123
y1998_0720_LT05_173026	1600	y2018_0524_LC08_173026	0
y1998_0821_LT05_173026	2552	y2018_0609_LC08_173026	0
y1998_1008_LT05_173026	3396	y2018_0711_LC08_173026	0
y1999_0317_LT05_173026	7144	y2018_0727_LC08_173026	1
y1999_0418_LT05_173026	6699	y2018_0812_LC08_173026	0
y1999_0605_LT05_173026	1422	y2018_0828_LC08_173026	6182
y1999_0808_LT05_173026	1197	y2018_0913_LC08_173026	5231
y1999_0816_LE07_173026	810	y2018_1015_LC08_173026	4415
y2000_0530_LE07_173026	232	y2019_0425_LC08_173026	1231
y2000_0615_LE07_173026	1681	y2019_0511_LC08_173026	739
y2000_0717_LE07_173026	1315	y2019_0815_LC08_173026	1142
y2000_0810_LT05_173026	1378	y2019_0916_LC08_173026	2092
y2000_1013_LT05_173026	1720	y2020_0326_LC08_173026	0
y2001_0517_LE07_173026	0	y2020_0716_LC08_173026	0
y2001_0525_LT05_173026	0	y2020_0817_LC08_173026	1
y2001_0728_LT05_173026	1709	y2020_0902_LC08_173026	653
y2001_0805_LE07_173026	977	y2020_0918_LC08_173026	572
y2001_0813_LT05_173026	714	y2021_0703_LC08_173026	0
y2001_0922_LE07_173026	26	y2021_0719_LC08_173026	0
y2002_0317_LE07_173026	3213		

**Table S4.** ANOVA of the difference between soil varieties by thickness of humus horizon.

	Sum of Squares	df	Mean Square	F	p-Value	F Crit
Between groups	7396.04	4	1849.01	105.88	4.66×10 <sup>-30</sup>	2.49
Within groups	1309.76	75	17.46			
Total	8705.80	79				

**Table S5.** ANOVA of the difference between soil varieties by OM content.

	Sum of Squares	df	Mean Square	F	p-Value	F Crit
Between groups	18.25	4	4.56	95.47	1.21×10 <sup>-28</sup>	2.49
Within groups	3.59	75	0.05			
Total	21.84	79				