

Sentinel-2 and Random forest for ecosystem-habitat mapping: A case study over Lazio (Italy)

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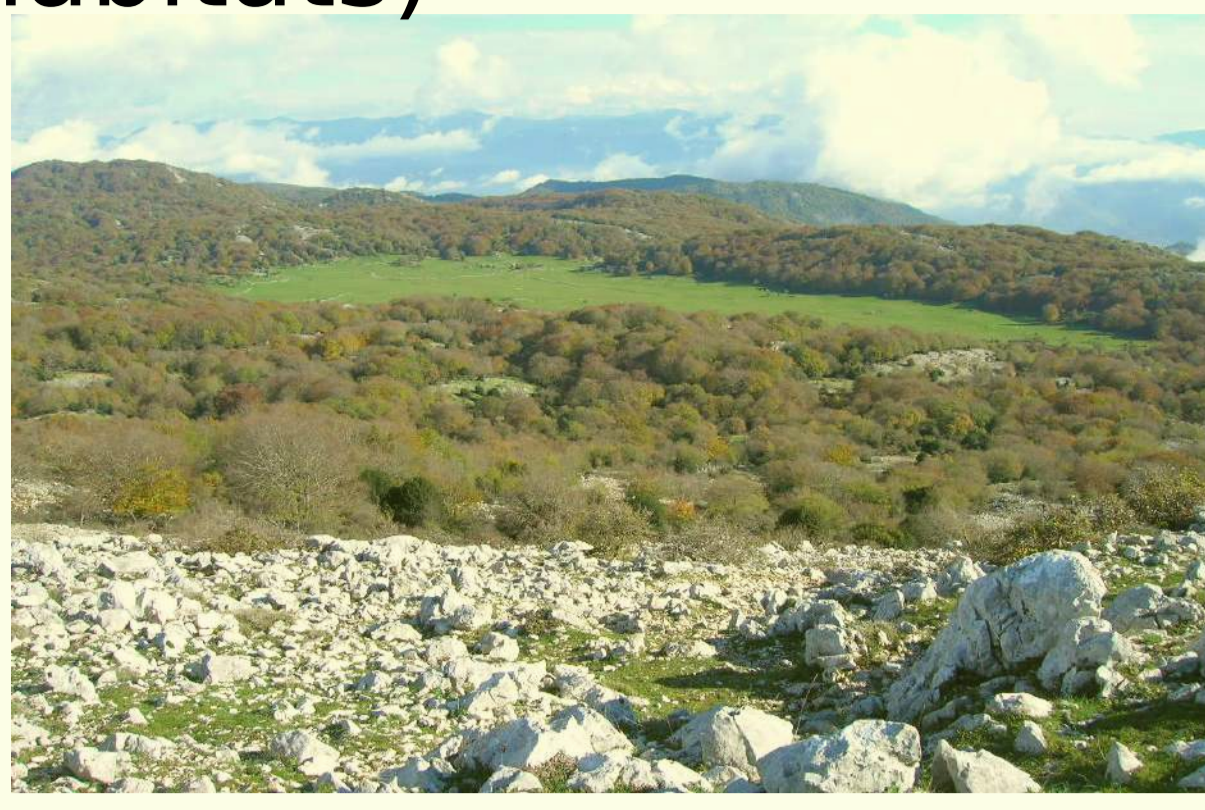


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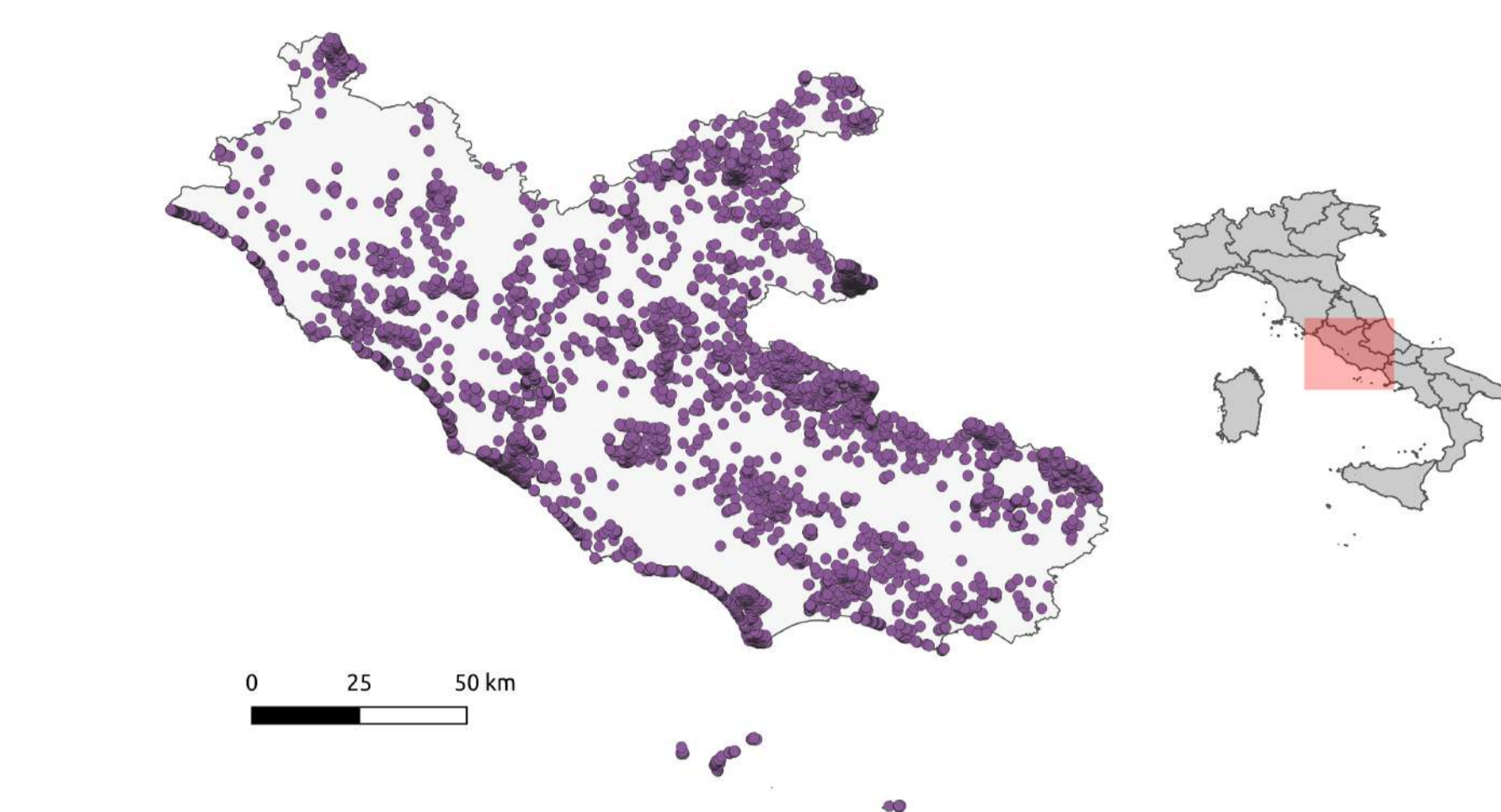
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We classified 44 habitats of which 41 defined in Annex I Directive 92/43/EEC.
Habitat Macro-classes (and number of classified habitats)

- 1) COASTAL AND HALOPHYTIC HABITATS (5)
- 2) COASTAL SAND DUNES AND INLAND DUNES (7)
- 3) FRESHWATER HABITATS (1)
- 4) TEMPERATE HEATH AND SCRUB (1)
- 5) SCLEROPHYLLOUS SCRUB-MATORRAL (5)
- 6) NATURAL AND SEMI-NATURAL GRASSLAND FORMATIONS (7)
- 7) RAISED BOGS AND MIRE AND FENS (0)
- 8) ROCKY HABITATS AND CAVES (5)
- 9) FORESTS (13)



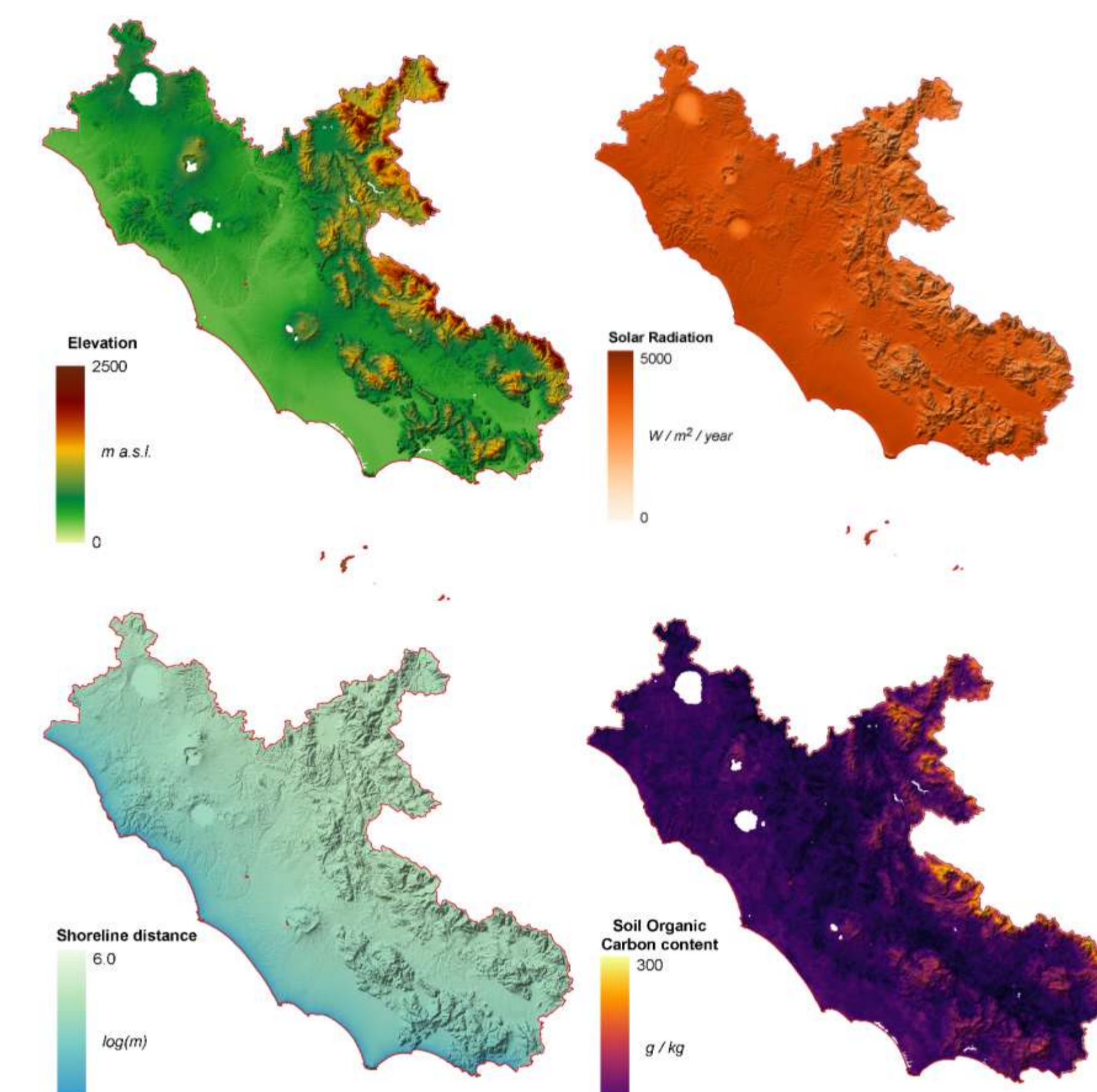
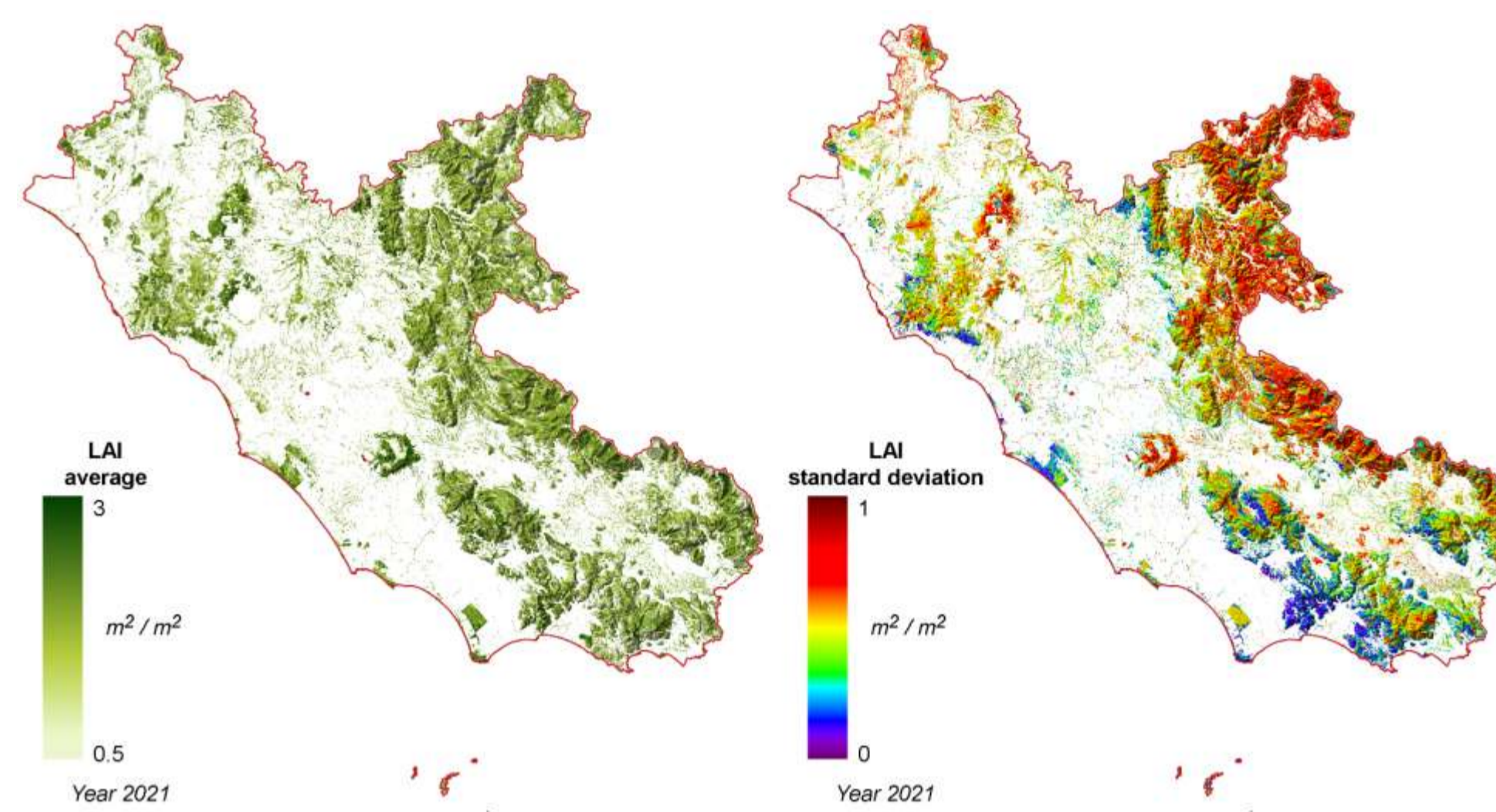
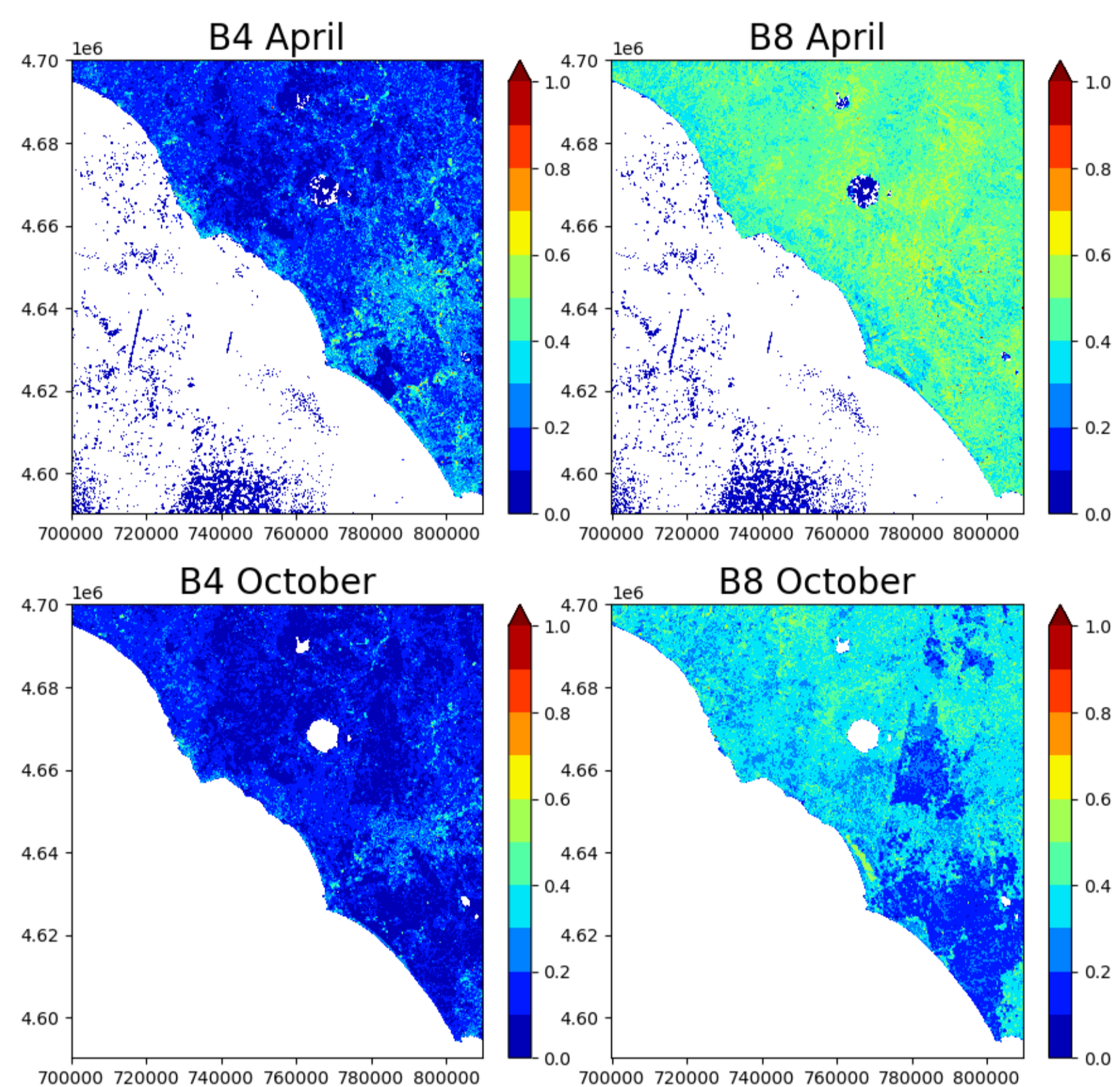
Region of Interest and Random Forest Target Points



Example of Spectral Predictors

Example of Leaf Area Index statistics

Example of Environmental Predictors



A mask of natural areas of region was created using land cover products and CLC+ Backbone

DIRECT CLASSIFICATION of FORESTS and HIERARCHICAL CLASSIFICATION of NON FOREST classes

NON FOREST 3, 4, 5 and 6 habitat categories were grouped in a new macro-class (66), then a first level of classification was performed with classes 11 (habitats code 1 + naked sand), 22 (habitats code 2 minus class 2270, which is a forest type and was assigned to FOREST CLASS), 66 and 88 (habitat code 8 + naked rock). Once discriminated the macro-classes with this first random forest model, a mask for each macro-class was created and a second level of classification was applied to single classes 11, 22, 66 and 88. FORESTS habitats were classified directly instead. We added 2270 and afforestation with coniferous trees, indicated as 9999.

CONFUSION MATRIXES with accuracies and accuracy standard errors

Macro_classes

Map Class	Reference Class				Sum	UA (SE)
	11	22	66	88		
11	66	15	1	0	82	80.5 (4.4)
22	24	284	12	0	320	88.8 (1.8)
66	0	12	768	48	828	92.8 (0.9)
88	0	0	18	61	79	77.2 (4.7)
Sum	90	311	799	109		OA (SE) 90.1 (0.9)
PA (SE)	73.3 (2.7)	91.3 (5.7)	96.1 (0.0)	56 (1.2)		Kappa 0.82

Map Class	Reference Class					Sum	UA (SE)
	1111	1210	1310	1410	1420		
1111	27	7	0	0	0	34	79.4 (7.0)
1210	9	28	1	2	0	40	70.0 (7.3)
1310	0	0	0	4	1	5	0 (0.00)
1410	0	1	7	23	3	34	67.6 (8.1)
1420	0	0	5	2	2	9	22.2 (14.7)
Sum	36	36	13	31	6		OA (SE) 65.6 (4.5)
PA (SE)	75.0 (0.9)	77.8 (6.7)	0 (0.00)	74.2 (5.7)	33.3 (18.9)		Kappa 0.54

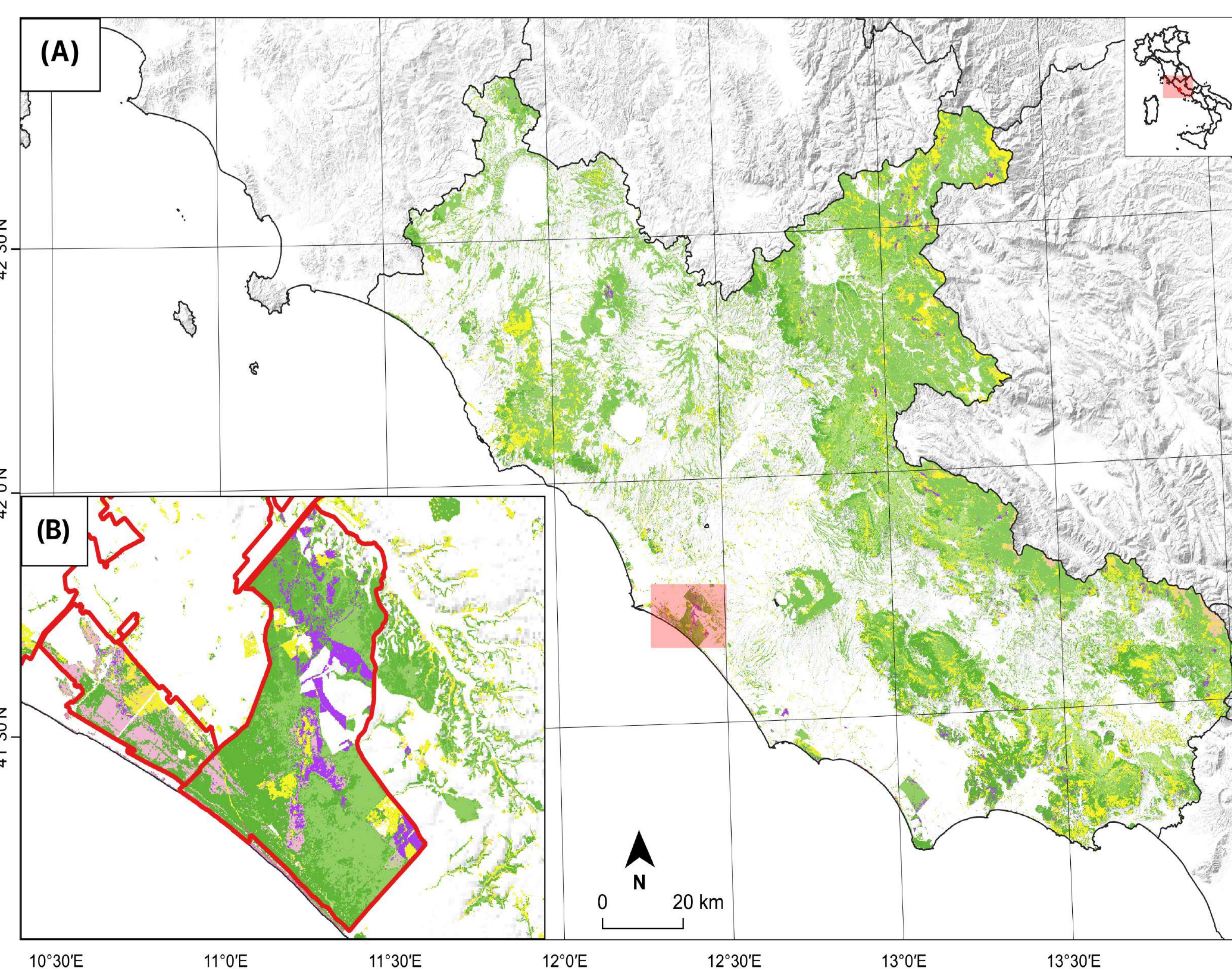
Map Class	Reference Class					Sum	UA
	2110	2120	2210	2230	2250		
2110	47	14	15	3	0	79	59.5 (5.6)
2120	11	22	8	2	1	45	48.9 (7.5)
2210	7	8	22	8	3	51	43.1 (7.0)
2230	2	0	4	19	0	25	76.0 (8.7)
2250	0	3	6	1	20	16	43.5 (7.3)
2260	3	1	1	7	16	43	60.0 (5.8)
Sum	70	48	56	40	63		OA (SE) 54.6 (3.1)
PA (SE)	67.1 (5.1)	45.8 (5.8)	39.3 (4.2)	47.5 (4.5)	50.0 (6.0)	68.3 (3.2)	Kappa 0.45

66

Map Class	Reference Class													Sum	UA (SE)	
	3240	4060	5130	5210	5230	5320	5330	6110	6170	6210	6220	6230	6420			6430
3240	9	0	0	0	0	0	0	0	0	0	0	0	0	0	9	100 (0)
4060	0	81	0	0	0	0	0	16	24	0	7	0	1	129	62.8 (4.3)	
5130	2	1	16	0	0	0	0	0	2	0	1	0	0	22	72.7 (9.7)	
5210	0	0	0	7	0	0	0	0	0	0	0	0	2	9	77.8 (14.7)	
5230	0	0	0	1	7	0	1	0	0	2	0	0	1	12	58.3 (14.8)	
5320	0	0	0	0	0	2	0	0	0	0	0	0	0	2	100 (0)	
5330	0	0	0	2	0	37	0	2	9	0	0	0	0	50	74 (6.3)	
6110	0	0	0	0	0	0	6	0	3	0	0	0	0	9	66.7 (16.7)	
6170	0	17	2	0	0	0	0	46	7	0	12	0	0	84	54.8 (5.5)	
6210	4	21	16	1	0	0	5	7	21	203	20	2	3	306	66.3 (2.7)	
6220	0	0	2	0	2	4	14	10	0	18	108	0	7	170	63.5 (3.7)	
6230	0	7	0	0	0	0	0	11	1	0	43	0	0	62	69.4 (5.9)	
6420	0	0	0	0	0	0	0	0	0	0	0	1	1	2	50.0 (50)	
6430	2	0	1	0	0	0	1	0	3	3	1	2	37	50	74.0 (6.3)	
Sum	17	127	37	11	9	6	57	24	94	260	145	66	13	50		OA (SE) 65.8 (2.0)
PA (SE)	52.9 (7.8)	63.8 (4.5)	43.2 (4.0)	63.6 (15.3)	77.8 (14.9)	33.3 (2.2)	64.9 (4.6)	25 (0.03)	48.9 (1.8)	78.1 (0.92)	74.5 (2.4)	65.2 (2.2)	7.7 (6.7)	74 (8.0)		Kappa 0.59

FORESTS

Map Class	Reference Class													Sum	UA (SE)		
	2270	9180	91AA	91B0	91F0	91L0	91M0	9210	9260	92A0	9330	9340	9540				
2270	9	0	0	0	1	0	0	0	0	0	0	0	5	0	5	20	45 (11.4)
9180	0	15	0	0	0	2	5	9	5	3	1	5	0	0	45	33.3 (7.1)	
91AA	0	2	22	0	0	1	5	1	10	1	0	3	0	1	46	47.8 (7.4)	
91B0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	5	60 (24.5)	
91F0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0 (0)	
91L0	0	1	1	0	0	5	4	1	2	2	0	0	0	0	16	31.2 (12)	
91M0	1	10	18	6	6	28	172	13	16	9	3	16	0	1	299	57.5 (2.9)	
9210	0	5	4	0	0	1	4	165	5	0	0	2	0	1	187	88.2 (2.4)	
9260	0	6	2	0	0	2	1	3	53	0	0	5	0	0	72	73.6 (5.2)	
92A0	0	3	1	0	1	0	6	0	0	43	0	2	0	0	56	76.8 (5.7)	
9330	0	1	3	0	0	2	4	0	1	0	59	8	0	0	78	75.6 (4.9)	
9340	6	6	8	1	3	4	20	2	7	1	24	161	0	3	246	65.4 (3.0)	
9540	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	100 (0)	
9999	3	0	0	0	0	0	2	1	0	0	1	8	0	100	115	87 (3.1)	
Sum	19	49	59	10	11	45	225	195	99	59	88	216	4	111		OA (SE) 68.2 (1.5)	
PA	47.4 (4.0)	30.6 (6.4)	35.6 (5.5)	30 (0.9)	11.1 (0.00)	76.4 (2.1)	84.6 (2.5)	53.5 (2.7)	72.9 (4.1)	67 (6.5)	74.5 (4.6)	100 (3.1)	0 (9.5)	90.1		Kappa 0.63	
(SE)																	



Habitats classification	
1111 - Sand beach	6210(*) - Semi-natural dry grasslands and scrubland facies on calcareous substrates
1210 - Annual vegetation of drift lines	6220 - Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea
1310 - Salicornia and other annuals colonizing mud and sand	6230 - Species-rich Nardus grasslands, on siliceous substrates in mountain areas
1410 - Mediterranean salt meadows	6420 - Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion
1420 - Mediterranean and thermo-Atlantic halophilous scrubs	6430 - Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
2110 - Embryonic shifting dunes	8120 - Calcareous and calcichist scrubs of the montane to alpine levels
2120 - Shifting dunes along the shoreline with Ammophila arenaria	8130 - Western Mediterranean and thermophilous scree
2210 - Crucianellion maritima fixed beach dunes	8210 - Calcareous rocky slopes with chasmophytic vegetation
2230 - Malcolmieta dune grasslands	8240 - Limestone pavements*
2250 - Coastal dunes with Juniperus spp.	8888 - Rock
2260 - Cisto-Lavanduletalia dune sclerophyllous scrubs	9180 - Tilio-Acerion forests
2270 - Wooded dunes with Pinus	91AA - Eastern white oak woods
3240 - Alpine rivers and their ligneous vegetation	91B0 - Thermophilous Fraxinus woods
4060 - Alpine and Boreal heaths	91F0 - Riparian mixed forests
5130 - Juniperus communis formations on heaths or calcareous grasslands	91L0 - Illyrian oak-hornbeam forests
5210 - Matorral arborescenti di Juniperus spp.	91M0 - Pannonian-Balkan turkey oak forests
5230 - Arborescent matorral with Laurus nobilis	9210 - Apennine beech forests
5320 - Low formations of Euphorbia close to cliffs	9260 - Castanea sativa woods
5330 - Thermo-Mediterranean and pre-desert scrub	92A0 - Salix alba and Populus alba galleries
6110 - Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	9330 - Quercus suber forests
6170 - Alpine and subalpine calcareous grasslands	9340 - Quercus ilex and Quercus rotundifolia forests
	9540 - Mediterranean pine forests
	9999 - Afforestation of coniferous

(A) Lazio Habitat classification

(B) Presidential Estate of Castelporziano and Natural Reserve "Litorale Romano"

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