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DIPARTIMENTO
DI SCIENZE AGRARIE,
ALIMENTARI E AMBIENTALI

Analysis and conservation of secondary grasslands: the case of Maiella National Park

Parco Nazionale della Maiella

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°Maiella National Park

grassland habitats: the highest biodiversity in Europe

if we consider a small spatial grain,
grasslands* represent <u>the species-richest habitat in the world</u>: e.g. 89 species /m²

(at larger grains, of course the record is hold by tropical rain forests: e.g. 942 species /ha

Journal of Vegetation Science ■■ (2012)

FORUM

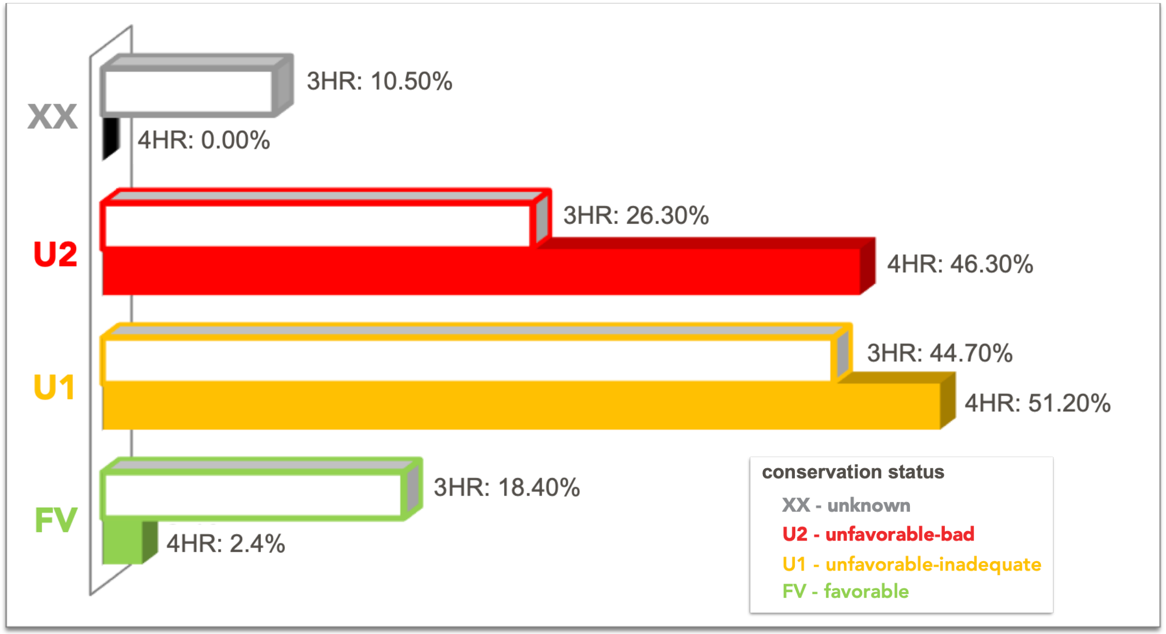
Plant species richness: the world records

J. Bastow Wilson, Robert K. Peet, Jürgen Dengler & Meelis Pärtel

*oligo- to mesotrophic, managed, semi-natural, temperate grasslands

Annex I grassland habitats: conservation status in italy

Results of the **Third** (3HR, 2007-12)
and the **Fourth** (4HR, 2013-18) **Reports ex-Art. 17**
(92/43/EEC "Habitats" Directive) in Italy
grasslands overview



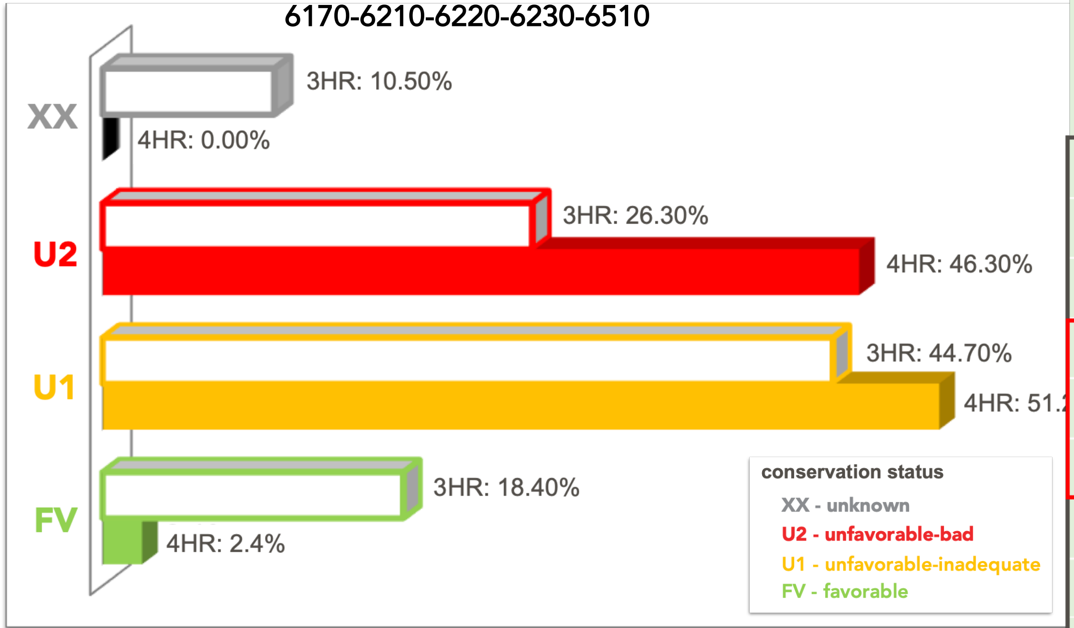
Distribution of level I pressure typologies in different habitat groups and species for the "Nature" Directives (overall results at EU level from Member States Reports, source: EEA, 2020)

Note: The size of the squares and their shade reflect the percentage of pressures for each group: bigger darker squares indicate higher percentages.

Source: Article 12 and Article 17 Member States' reports and assessments.

Annex I grassland habitats: conservation status in italy

Results of the **Third** (3HR, 2007-12)
and the **Fourth** (4HR, 2013-18) **Reports ex-Art. 17**
(92/43/EEC "Habitats" Directive) in Italy
5 grasslands habitats:
6170-6210-6220-6230-6510



Codice	Regioni biogeografiche	Habitat name	III REPORT (2007-2012) Range	Area	Structure and functions	Future prospects	Overal assessment	Overall trend	IV REPORT (2013-2018) Range	Area	Structure and functions	Future prospects	Overal assessment	Overall trend
6170	ALP	Alpine and subalpine calcareous grasslands					FV						U2	S
6170	CON	Alpine and subalpine calcareous grasslands					FV						U1	I
6170	MED	Alpine and subalpine calcareous grasslands					FV						U1	S
6210	ALP	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)					U1	D					U2	D
6210	CON	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)					U1	D					U2	D
6210	MED	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)					U1	D					U2	D
6220	ALP	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea					XX						U1	S
6220	CON	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea					U1	D					U2	D
6220	MED	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea					FV						U2	D
6230	ALP	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)					U2	D					U1	S
6230	CON	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)					U1	D					U2	D
6230	MED	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)					U1	D					U2	D
6510	ALP	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)					U2	D					U1	S
6510	CON	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)					U1	S					U1	I
6510	MED	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)					U1	D					U2	D

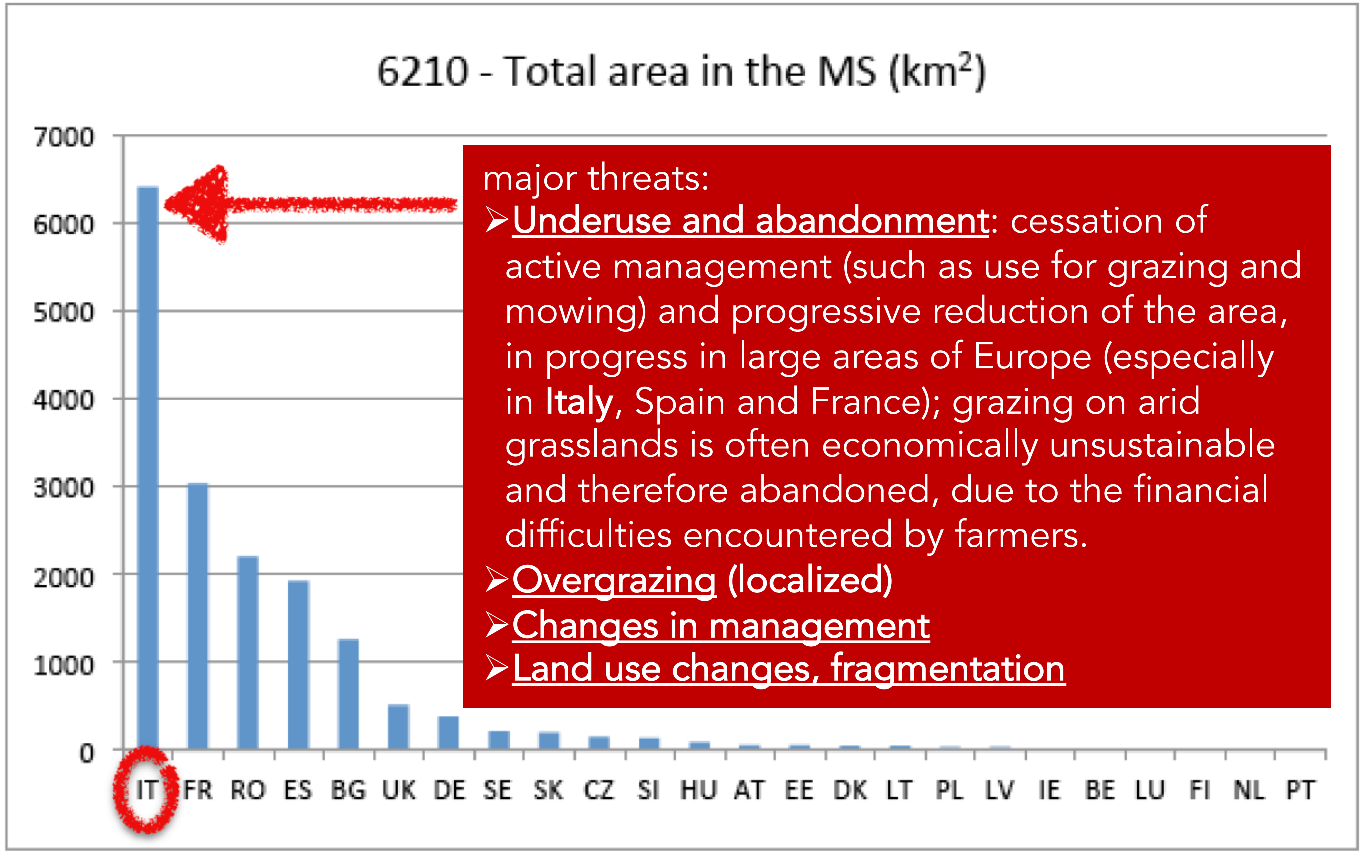
Annex I grassland habitats: EC focus on habitat **6210**

EU HABITAT ACTION PLAN

Action plan to maintain and restore to favourable conservation status the habitat type 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)

SERVICE CONTRACT FOR SUPPORTING THE DELIVERY OF THE ACTION PLAN FOR NATURE. PEOPLE AND THE ECONOMY IN RELATION TO ACTIONS 4. 5 AND 7 (ENV/D.3/SER/2017/0023)

European Commission, 2019



major threats:

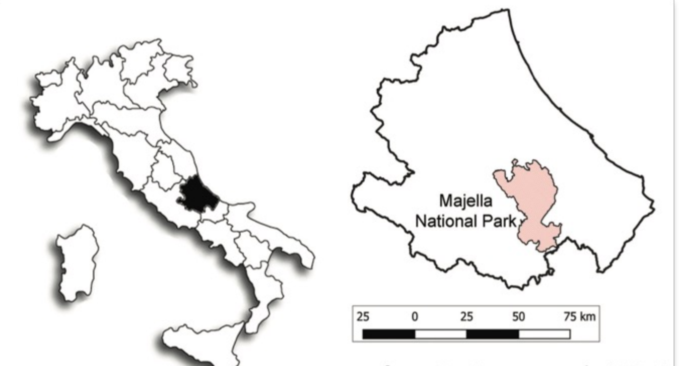
- <u>Underuse and abandonment</u>: cessation of active management (such as use for grazing and mowing) and progressive reduction of the area, in progress in large areas of Europe (especially in **Italy**, Spain and France); grazing on arid grasslands is often economically unsustainable and therefore abandoned, due to the financial difficulties encountered by farmers.
- <u>Overgrazing</u> (localized)
- <u>Changes in management</u>
- <u>Land use changes, fragmentation</u>

Surface area (km^2) of 6210 in the Member States

study area

Maiella National Park

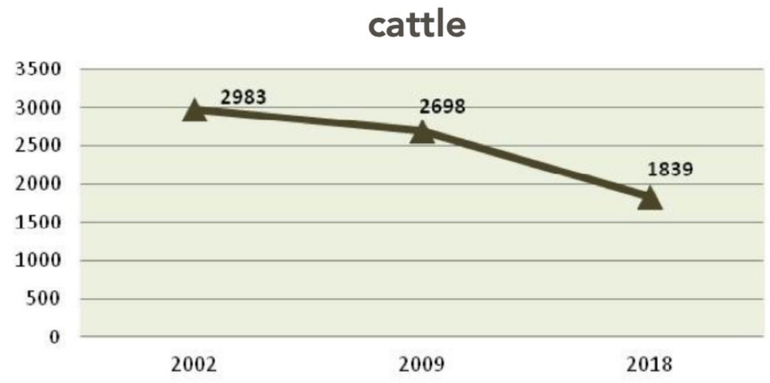
- ✓ established based on the law L394/91 and DPR 5/06/1995
- ✓ mostly NW-SE-oriented limestone ridges
- ✓ altitudinal range :**130 - 2,793** m a.s.l.
- ✓ area: ca. 74.000 ha
- ✓ from (Sub-)Mesomediterranean to Criotemperate Bioclimatic belts
- ✓ Natura 2000 network is represented by 1 SPA and 4 SACs
- ✓ 2,286 plant species, including 15 exclusive endemics (Conti et al. 2019)
- ✓ 10 vegetation series, from thermophilous white oak forests to high altitude primary vegetation
- ✓ one of the most threatened areas in Europe, mainly due to climate change (Gomez-Campo 1985; Di Cecco et al. 2020)



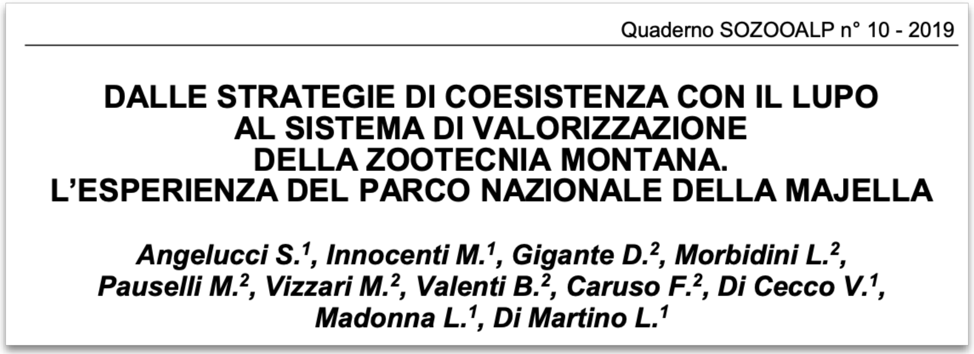
from Di Cecco et al. (2020)

study area

The territory of Maiella National Park (MNP) stands as an emblematic area in central Italy for both grasslands extent (ca. 22,000 ha as of 2014) and land depopulation, as well as for the drastic, long-lasting **trend of reduction in breeding activities and extensive livestock grazing**



sheep/goat and cattle load on MNP pastures in 2002, 2009 and 2018 (source MNP)


Quaderno SOZOOALP n° 10 - 2019

DALLE STRATEGIE DI COESISTENZA CON IL LUPO AL SISTEMA DI VALORIZZAZIONE DELLA ZOOTECNIA MONTANA. L'ESPERIENZA DEL PARCO NAZIONALE DELLA MAJELLA

Angelucci S.[1], Innocenti M.[1], Gigante D.[2], Morbidini L.[2], Pauselli M.[2], Vizzari M.[2], Valenti B.[2], Caruso F.[2], Di Cecco V.[1], Madonna L.[1], Di Martino L.[1]

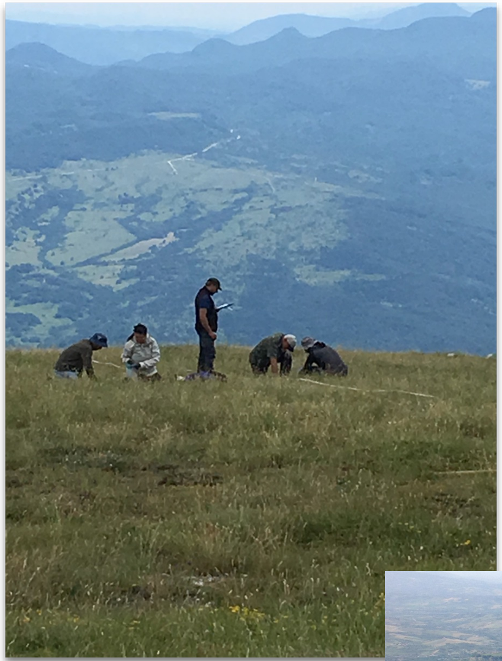
study targets

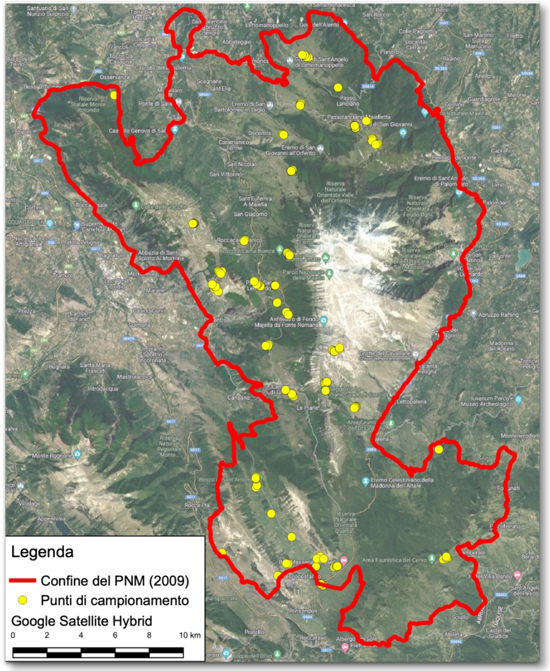
Study of the secondary grasslands and meadows (Annex I habitats 6170 (p.m.p.) - **6210** - **6230** - **6510**), with a focus on:

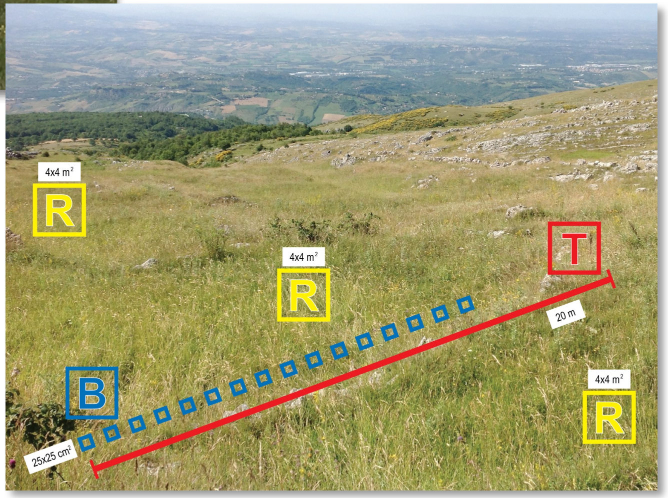
- ✓ plant community diversity and distribution
- ✓ pabular value of the pastures
- ✓ habitats distribution
- ✓ conservation issues & management challenges

metodology

- **remote sensing analysis** based on vegetation indexes (NDVI) and map of the main land use changes over the last 20 years, with identification of the main dynamic processes
- identification of homogeneous sampling sites, based on the ecological-environmental characteristics, representative of the territorial variability
- **vegetation survey** in 4x4 m^2 plots, 3 replicates in each site
- **characterization** of the grasslands by way of:
  - ✓ phytosociological interpretation
  - ✓ pastoral value (PV)
  - ✓ biomass collection, dry weight and main nutritional parameters analysis
  - ⇨ integration of the different approaches
- **web-GIS tools**
- support for grazing planning, based on the suitable grazing animal load and appropriate techniques



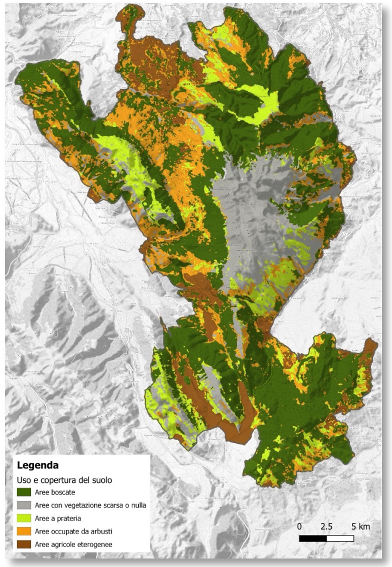




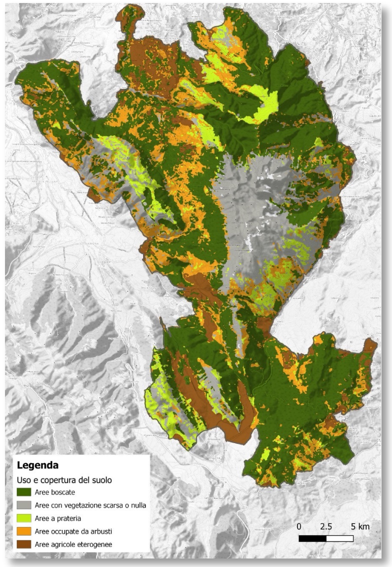

remote sensing
MDPI
Article
Pixel- vs. Object-Based Landsat 8 Data Classification in Google Earth Engine Using Random Forest: The Case Study of Maiella National Park
Andrea Tassi [1], Daniela Gigante [1], Giuseppe Modica [2], Luciano Di Martino [3] and Marco Vizzari [1,*]

results: remote sensing

- Landsat 8 data composition and classification process using Google Earth Engine (GEE); both pixel-based (**PB**) and object-based (**OB**) approaches, producing a detailed, 15-m resolution Land Cover map of the study area
- five spectral indices, some of them on an interannual basis, to account for vegetation seasonality
- “**Random Forest**” (RF) machine learning classifier
- randomly distributed 1200 ground truth points, 70% used to train the RF classifier and 30% for the validation phase
- 2 reference periods: 1999-2001 and 2018-2020

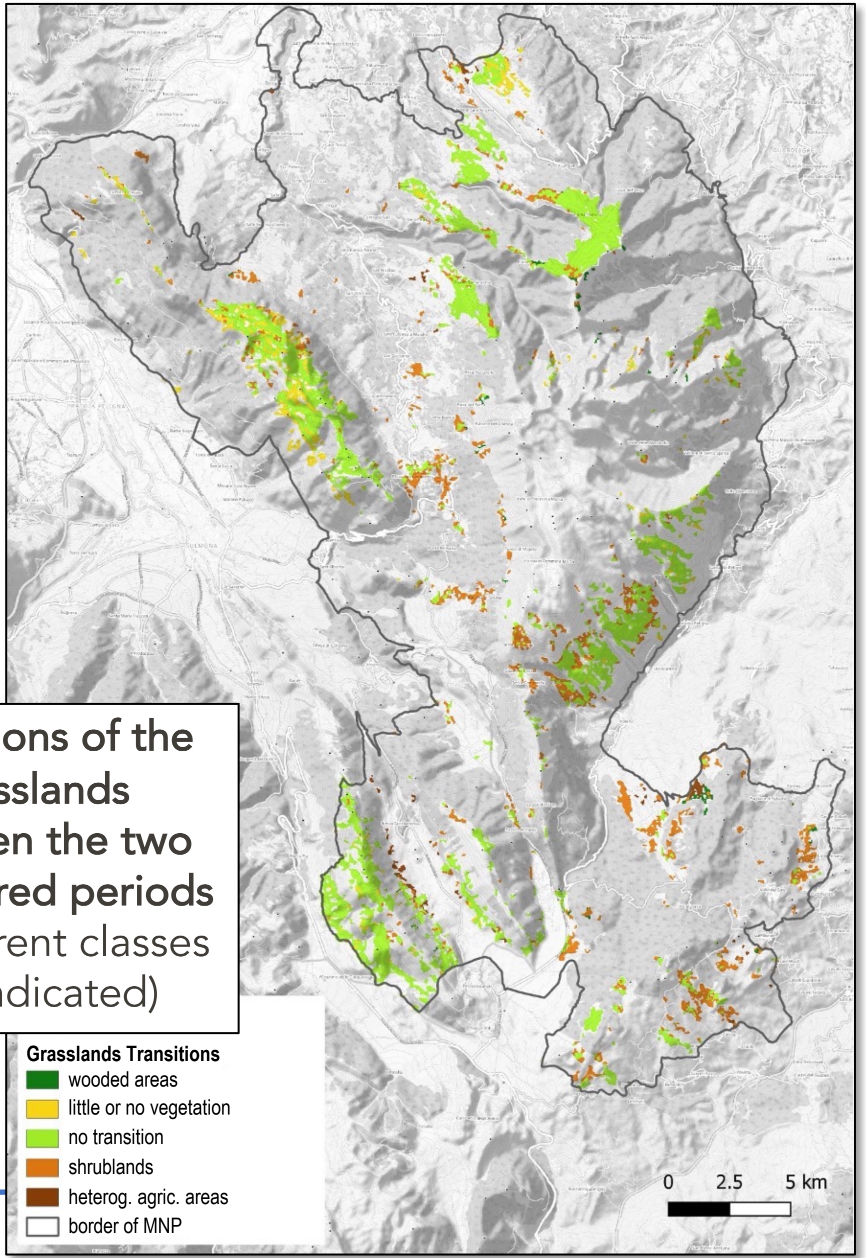


Land use and cover in the period I (1999-2001)



Land use and cover in the period II (2018-2020)

Transitions of the grasslands between the two considered periods (the current classes are indicated)



remote sensing — MDPI

Article

Pixel- vs. Object-Based Landsat 8 Data Classification in Google Earth Engine Using Random Forest: The Case Study of Maiella National Park

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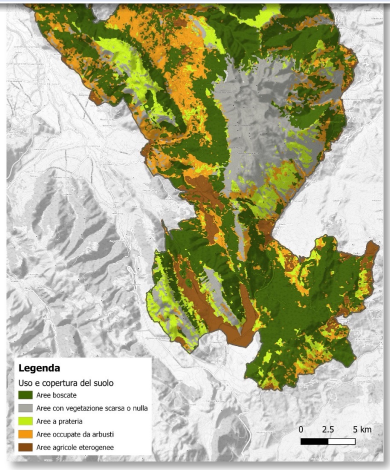
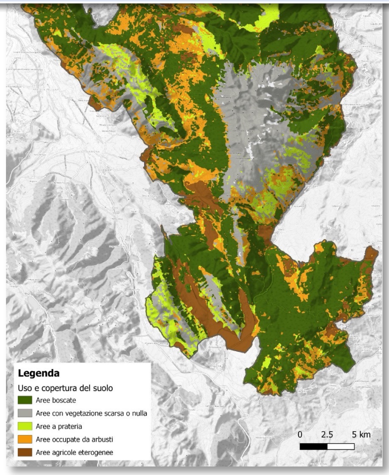
results: remote sensing

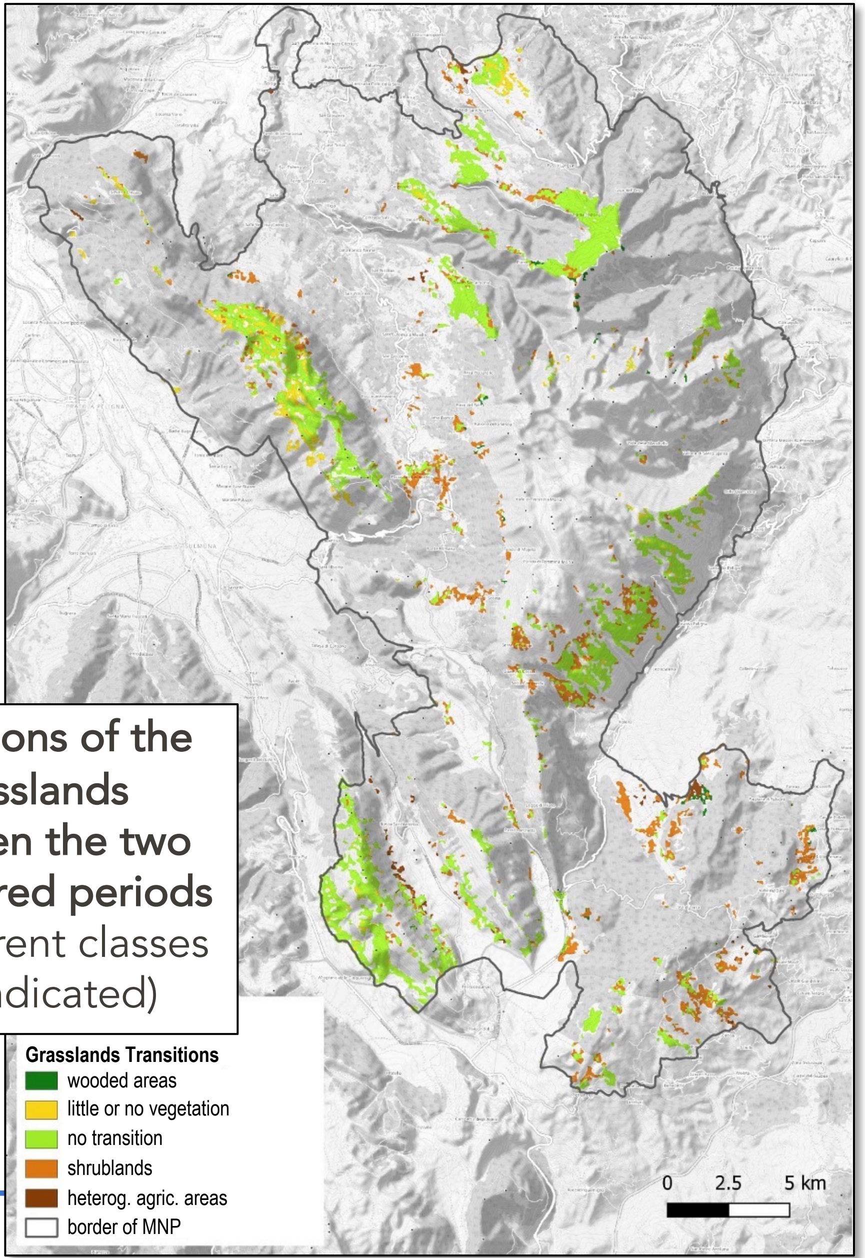
2000 \ 2020	wooded areas	little or no vegetation	grasslands and pastures	shrublands	heterogeneous agricultural areas	total
wooded areas	94.28%	1.36%	0.59%	3.54%	0.24%	100%
little or no vegetation	1.04%	89.74%	3.88%	5.11%	0.22%	100%
grasslands and pastures	**2.93%**	**11.29%**	**60.03%**	**23.82%**	**1.93%**	**100%**
shrublands	27.58%	5.34%	2.98%	61.70%	2.39%	100%
heterogeneous agricultural areas	3.24%	0.36%	0.41%	3.73%	92.26%	100%
total	**50.21%**	**16.10%**	**8.31%**	**16.66%**	**8.72%**	**100%**



Land use and cover
in the period I (1999-2001)



Land use and cover
in the period II (2018-2020)



Transitions of the grasslands between the two considered periods (the current classes are indicated)

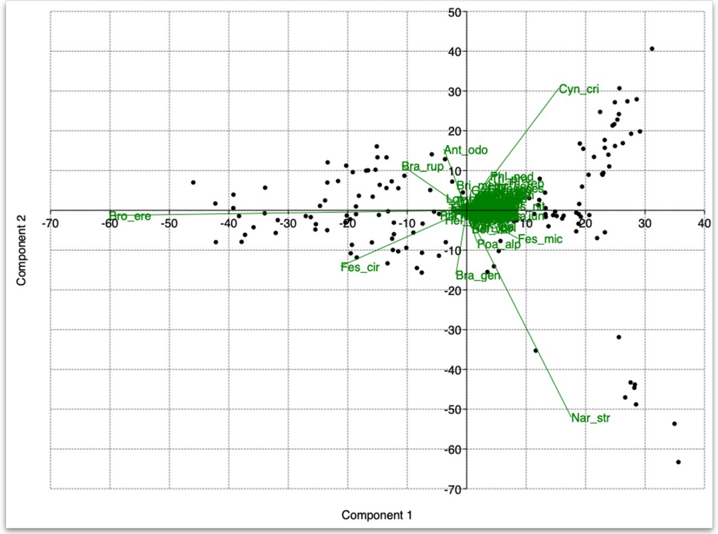
results: plant communities

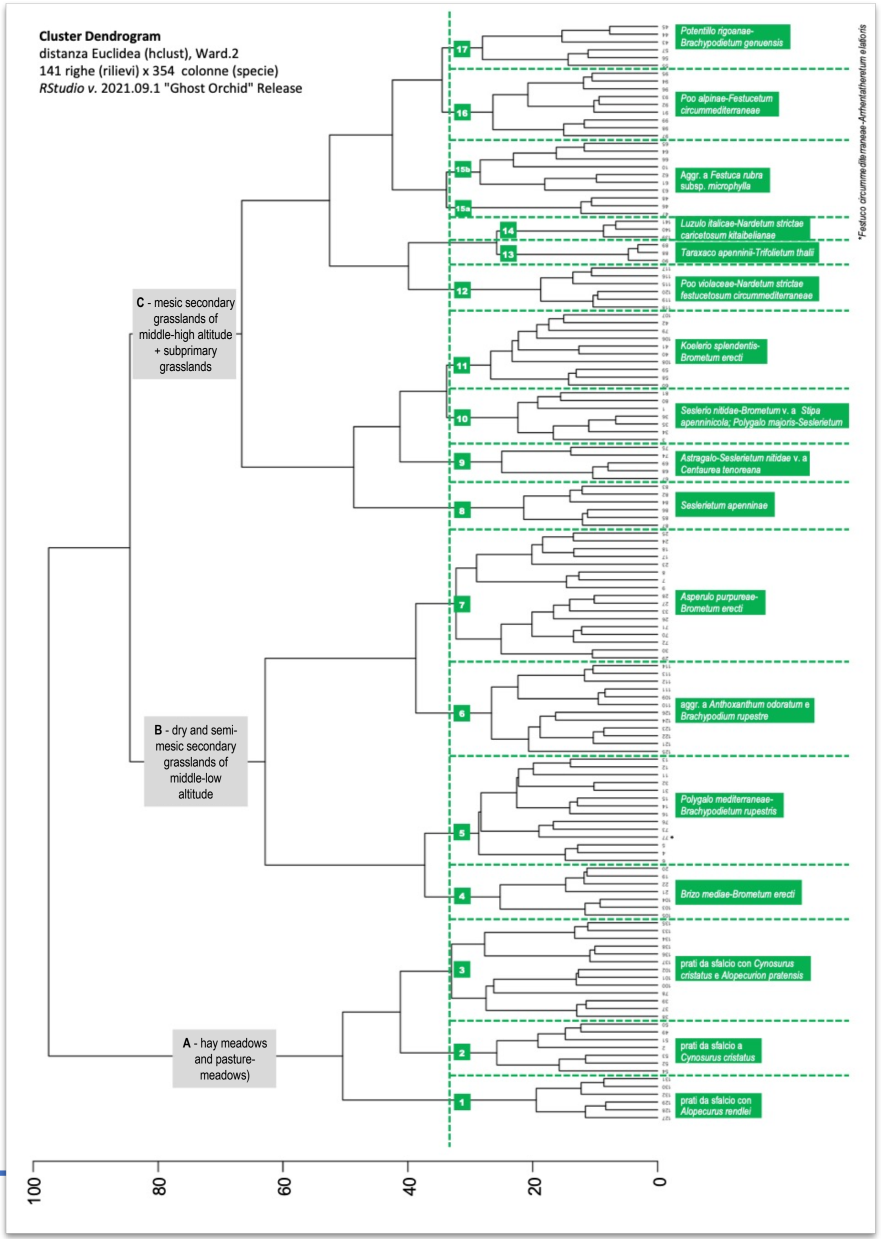
- ❖ period 2019-2020 - 141 vegetation surveys x 532 species
- ❖ Cluster analysis (Euclidean distance, Ward.2)
- ❖ Indicator Species analysis: package 'indicspecies', v.1.7.12; Association function “r.g", Significance level (alpha) = 0.05 (De Cáceres & Legendre 2009; De Caceres et al. 2011)
- ❖ statistical analyses performed with RStudio, v. "Ghost Orchid" Release

➢ **19 plant communities**

3 main groups:

- A - hay meadows and pasture-meadows of the karstic highlands: H **6510**
- B - dry and semi-mesic secondary grasslands of middle-low altitude: **H6210**, **H6220*** (fragments)
- C - mesic secondary grasslands of middle-high altitude and subprimary grasslands: **H6210**, **H6230*** (+H6170 *pro minima parte*)

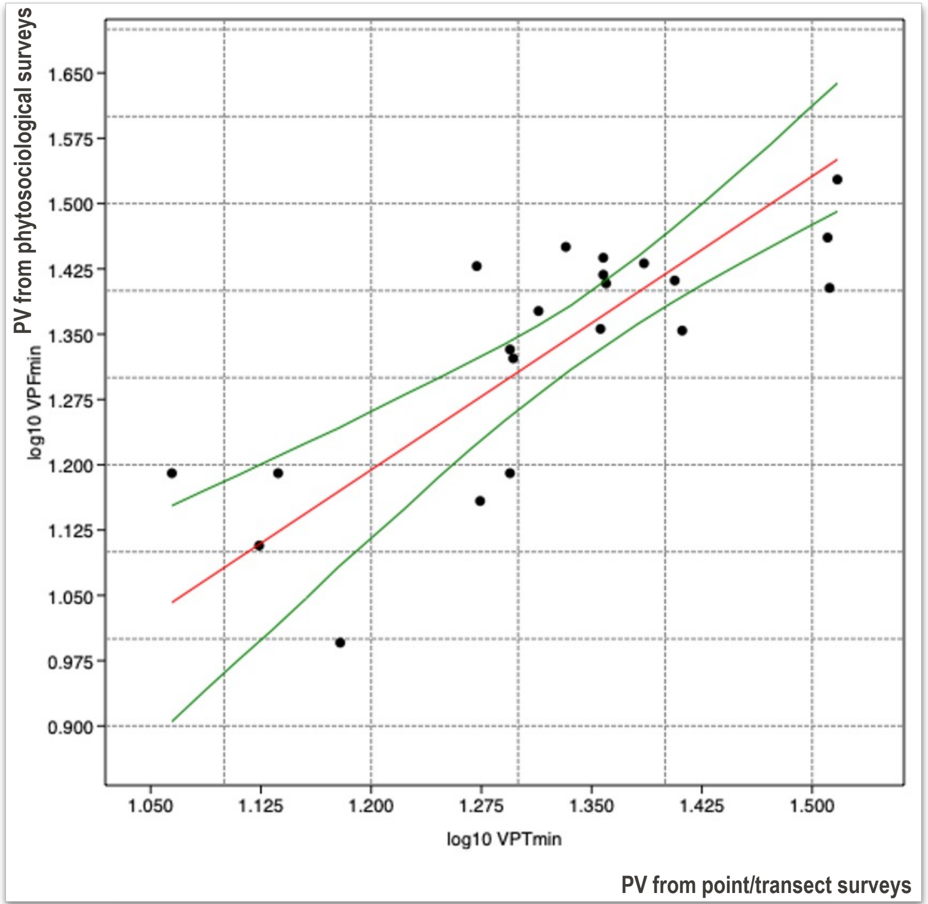




results: pastoral value (PV)

specific index (IS): synthetic index that takes into account various aspects of each species composing a grassland: productivity, nutritional value, palatability (or pabularity), taste, digestibility, and resistance to grazing -> expression of different **geographical areas** and **ecological conditions** of growth

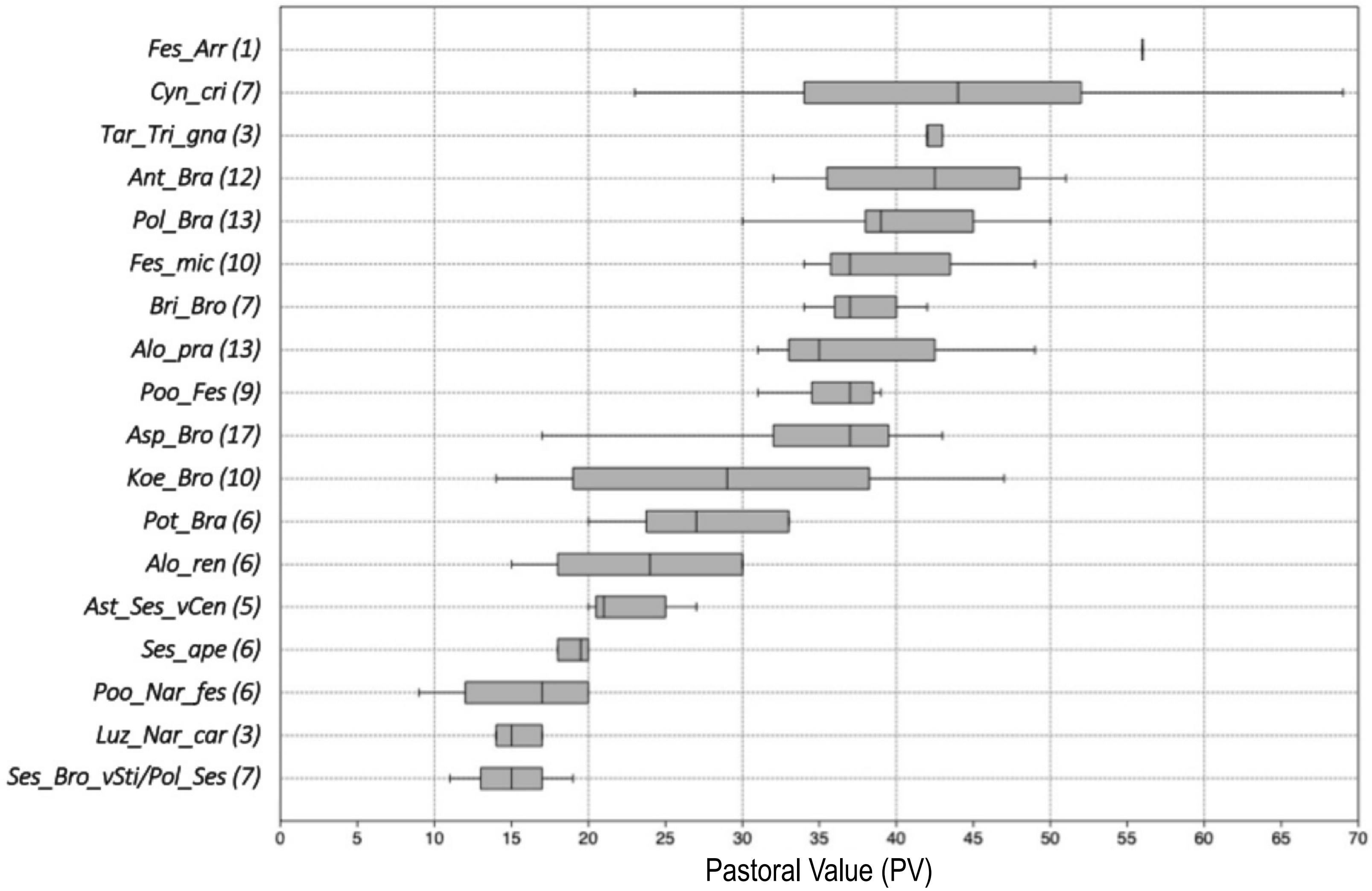
- ✓ starting from the IS archive developed by Roggero et al. (2002), and adding the most recent contributions, a matrix was constructed with the IS values used in the central-Mediterranean areas; only those from **central Apennine** were selected and used
- ✓ in order to make estimates of the Pastoral Value as reliable as possible, for each species both the **maximum** and **minimum** IS found in the **central Apennine** literature were taken into consideration: the obtained PVs therefore covers a range of values
- ✓ PV was calculated both from the point/transect surveys and from the phytosociological surveys (as proposed by Bagella & Roggero 2004) -> **a statistical comparison between the two sampling methods was carried out, showing a good correspondence of the 2 methods (r=0.78, p<0.001)**



RMA Regression: VPTmin-VPFmin, log-log transformed				
Slope a:	1.1239	Std. error a:	0.16031	
	t:	7.0109	p (slope):	1.12E-06
Intercept b:	-0.15453	Std. error b:	0.21282	
95% bootstrapped confidence intervals (N=1999):				
Slope a:	(0.66708, 1.4645)			
Intercept b:	(-0.62818, 0.46078)			
Correlation:				
r:	0.78323			
r2:	0.61345			
t:	5.4911			
p (uncorr.):	2.69E-05			
Permutation p:	0.0001			

results: pastoral value (PV)

❖ ranges of pastoral values (PV) for the detected plant communities



One-way ANOVA - Test for equal means

	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	11397.8	16	712.362	17.64	1.22E-24
Within groups:	4967.18	123	40.3836	Permutation p (n=99999)	
Total:	16365	139	1.00E-05		
Components of variance (only for random effects):					
Var(group):	82.6415	Var(error):	40.3836	ICC:	0.671745
omega2:	0.6554				
Levene´s test for homogeneity of variance, from means	p (same):	0.0001074			
Levene´s test, from medians	p (same):	0.0008801			
Welch F test in the case of unequal variances: F=143.3, df=35.9, p=1.272E-27					
Bayes factor: 1.944E21 (decisive evidence for unequal means)					

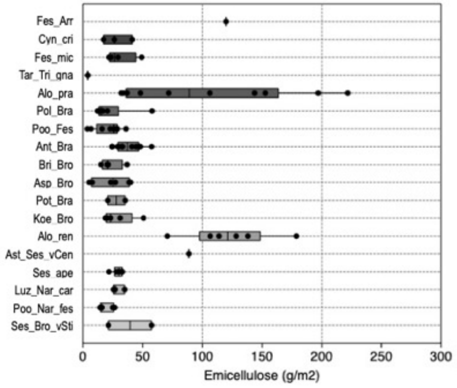
Statistically significant differences (Mann-Whitney pairwise, raw p-values, sequential Bonferroni significance):

	Ses_Bro_vSti/Pol_Ses (7)	Luz_Nar_car (3)	Poo_Nar_fes (6)	Ses_ape (6)	Ast_Ses_vCen (5)	Alo_ren (6)	Pot_Bra (6)	Koe_Bro (10)	Asp_Bro (17)	Poo_Fes (9)	Alo_pra (13)	Bri_Bro (7)	Fes_mic (10)	Pol_Bra (13)	Ant_Bra (12)	Tar_Tri_gna (3)	Cyn_cri (7)
Ses_Bro_vSti/Pol_Ses (7)		0.908	0.471	0.010	0.006	0.018	0.003	0.005	0.000	0.001	0.000	0.002	0.001	0.000	0.000	0.022	0.002
Luz_Nar_car (3)	0.908		0.692	0.025	0.036	0.068	0.028	0.042	0.009	0.016	0.010	0.022	0.014	0.010	0.011	0.077	0.023
Poo_Nar_fes (6)	0.471	0.692		0.157	0.012	0.064	0.008	0.026	0.001	0.002	0.001	0.003	0.001	0.001	0.001	0.026	0.003
Ses_ape (6)	0.010	0.025	0.157		0.015	0.195	0.009	0.100	0.002	0.002	0.001	0.003	0.001	0.001	0.001	0.024	0.003
Ast_Ses_vCen (5)	0.006	0.036	0.012	0.015		0.783	0.141	0.580	0.004	0.003	0.002	0.006	0.003	0.002	0.002	0.035	0.012
Alo_ren (6)	0.018	0.068	0.064	0.195	0.783		0.334	0.355	0.002	0.002	0.001	0.003	0.001	0.001	0.001	0.027	0.012
Pot_Bra (6)	0.003	0.028	0.008	0.009	0.141	0.334		1.000	0.009	0.004	0.004	0.003	0.001	0.002	0.002	0.027	0.027
Koe_Bro (10)	0.005	0.042	0.026	0.100	0.580	0.355	1.000		0.092	0.101	0.040	0.078	0.026	0.010	0.005	0.051	0.028
Asp_Bro (17)	0.000	0.009	0.001	0.002	0.004	0.002	0.009	0.092		1.000	0.753	0.632	0.290	0.053	0.027	0.022	0.061
Poo_Fes (9)	0.001	0.016	0.002	0.002	0.003	0.002	0.004	0.101	1.000		0.973	0.709	0.485	0.050	0.069	0.015	0.124
Alo_pra (13)	0.000	0.010	0.001	0.001	0.002	0.001	0.004	0.040	0.753	0.973		0.604	0.276	0.180	0.076	0.176	0.163
Bri_Bro (7)	0.002	0.022	0.003	0.003	0.006	0.003	0.003	0.078	0.632	0.709	0.604		0.730	0.175	0.175	0.037	0.200
Fes_mic (10)	0.001	0.014	0.001	0.001	0.003	0.001	0.001	0.026	0.290	0.485	0.276	0.730		0.455	0.390	0.201	0.406
Pol_Bra (13)	0.000	0.010	0.001	0.001	0.002	0.001	0.002	0.010	0.053	0.050	0.180	0.175	0.455		0.478	0.377	0.404
Ant_Bra (12)	0.000	0.011	0.001	0.001	0.002	0.001	0.002	0.005	0.027	0.069	0.076	0.175	0.390	0.478		1.000	0.832
Tar_Tri_gna (3)	0.022	0.077	0.026	0.024	0.035	0.027	0.027	0.051	0.022	0.015	0.176	0.037	0.201	0.377	1.000		0.645
Cyn_cri (7)	0.002	0.023	0.003	0.003	0.012	0.012	0.027	0.028	0.061	0.124	0.163	0.200	0.406	0.404	0.832	0.645	

results: nutritional parameters

❖ **analyzed parameters**:

- ✓ Net dry weight
- ✓ EE (total lipids - ethereal extract)
- ✓ NDF (neutral-clean fiber)
- ✓ ADF (cellulose + lignin)
- ✓ ADL (non-digestible fraction)
- ✓ EMICELL (fastest digestible fraction)
- ✓ CELL (slowly digestible fraction)
- ✓ PG (rough protein)
- ✓ Soluble Sugars



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	93775.5	14	6698.25	7.686	2.225E-09
Within groups:	59258.6	68	871.451		Permutation p (n=99999)
Total:	153034	82			1E-05

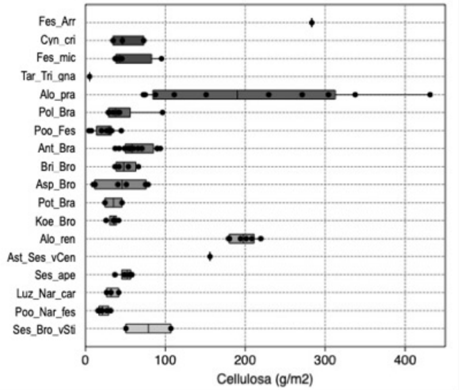
Components of variance (only for random effects):
Var(group): 1072.68 Var(error): 871.451 ICC: 0.551752

omega^2: 0.53

Levene´s test for homogeneity of variance, from means p (same): 3.918E-10
Levene´s test, from medians p (same): 2.417E-08

Welch F test in the case of unequal variances: F=3.734, df=15.51, p=0.007393

Bayes factor: 5.6E07 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	337455	14	24103.9	10.02	1.16E-11
Within groups:	163612	68	2406.06		Permutation p (n=99999)
Total:	501067	82			1E-05

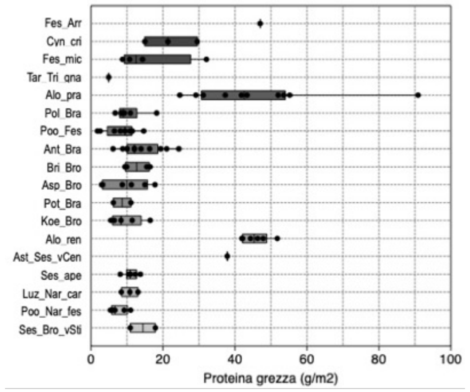
Components of variance (only for random effects):
Var(group): 3994.44 Var(error): 2406.06 ICC: 0.624082

omega^2: 0.6033

Levene´s test for homogeneity of variance, from means p (same): 2.3E-13
Levene´s test, from medians p (same): 6.853E-12

Welch F test in the case of unequal variances: F=31.34, df=15.51, p=9.218E-09

Bayes factor: 1.443E10 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	15880	14	1134.29	16.36	1.434E-16
Within groups:	4713.68	68	69.3188		Permutation p (n=99999)
Total:	20593.7	82			1E-05

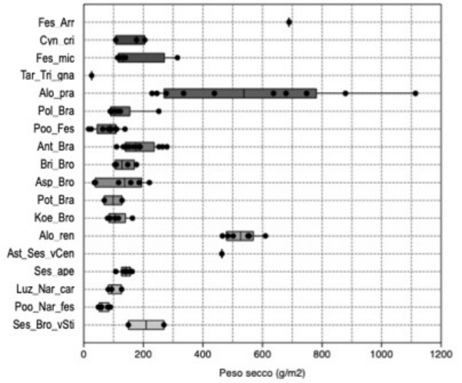
Components of variance (only for random effects):
Var(group): 196.054 Var(error): 69.3188 ICC: 0.738787

omega^2: 0.7216

Levene´s test for homogeneity of variance, from means p (same): 0.002087
Levene´s test, from medians p (same): 0.02715

Welch F test in the case of unequal variances: F=25.11, df=15.59, p=4.334E-08

Bayes factor: 9.128E14 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	2.34085E06	14	167203	11.59	4.909E-13
Within groups:	980706	68	14422.2		Permutation p (n=99999)
Total:	3.32155E06	82			1E-05

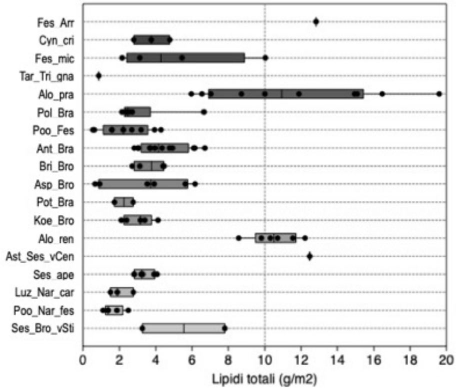
Components of variance (only for random effects):
Var(group): 28126.1 Var(error): 14422.2 ICC: 0.66104

omega^2: 0.6412

Levene´s test for homogeneity of variance, from means p (same): 4.129E-11
Levene´s test, from medians p (same): 4.484E-10

Welch F test in the case of unequal variances: F=20.65, df=15.52, p=1.857E-07

Bayes factor: 3.3E11 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	870.88	14	62.2057	12.37	1.14E-13
Within groups:	341.961	68	5.02884		Permutation p (n=99999)
Total:	1212.84	82			1E-05

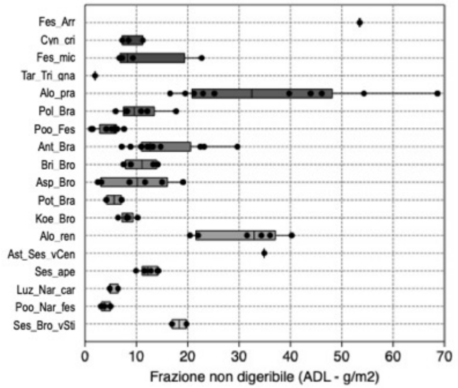
Components of variance (only for random effects):
Var(group): 10.5259 Var(error): 5.02884 ICC: 0.6767

omega^2: 0.6573

Levene´s test for homogeneity of variance, from means p (same): 2.446E-07
Levene´s test, from medians p (same): 3.46E-06

Welch F test in the case of unequal variances: F=13.71, df=15.68, p=2.912E-06

Bayes factor: 1.224E12 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	8578.99	14	612.785	10.09	9.885E-12
Within groups:	4128.01	68	60.7061		Permutation p (n=99999)
Total:	12707	82			1E-05

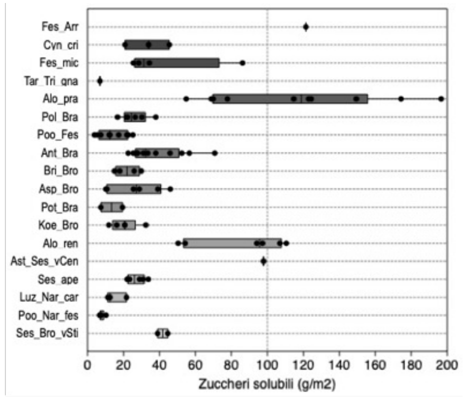
Components of variance (only for random effects):
Var(group): 101.634 Var(error): 60.7061 ICC: 0.626057

omega^2: 0.6054

Levene´s test for homogeneity of variance, from means p (same): 3.926E-09
Levene´s test, from medians p (same): 1.19E-06

Welch F test in the case of unequal variances: F=14.76, df=15.87, p=1.558E-06

Bayes factor: 1.497E10 (decisive evidence for unequal means)



	Sum of sqrs	df	Mean square	F	p (same)
Between groups:	90346.7	14	6453.33	13.72	1.036E-14
Within groups:	31992.2	68	470.473		Permutation p (n=99999)
Total:	122339	82			1E-05

Components of variance (only for random effects):
Var(group): 1101.41 Var(error): 470.473 ICC: 0.700694

omega^2: 0.682

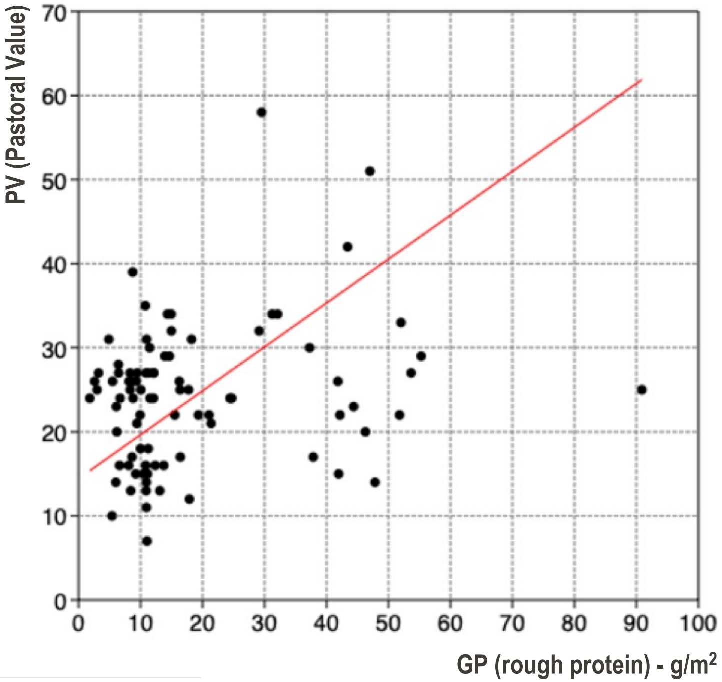
Levene´s test for homogeneity of variance, from means p (same): 5.22E-07
Levene´s test, from medians p (same): 9.596E-05

Welch F test in the case of unequal variances: F=17.43, df=15.36, p=6.866E-07

Bayes factor: 1.856E13 (decisive evidence for unequal means)

results: nutritional parameters

❖ positive correlations of some nutritional parameters with the Pastoral Value: proteins and sugars



RMA Regression

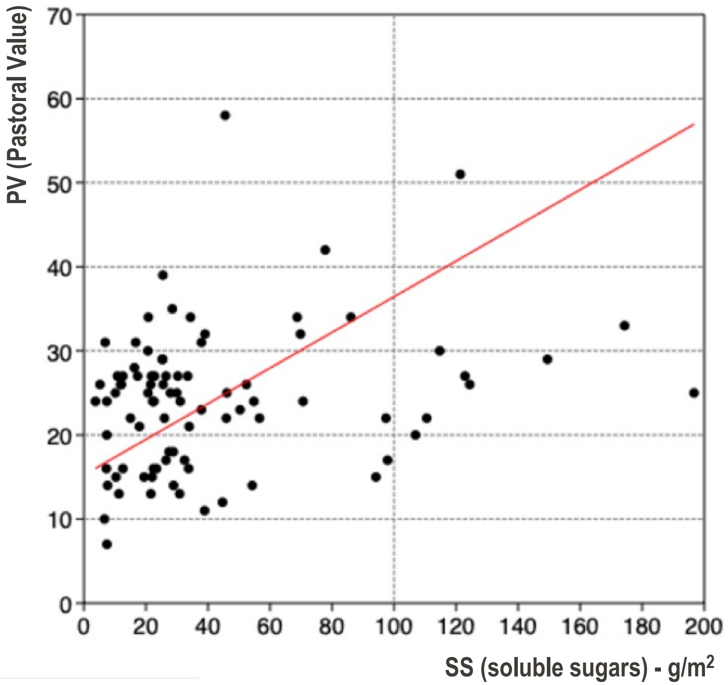
Slope *a*:	0.52201	**Std. error *a*:**	0.055512
***t*:**	9.4035	***p* (slope):**	9.1452E-15
Intercept *b*:	14.43	**Std. error *b*:**	1.5298

95% bootstrapped confidence intervals (*N*=1999):

Slope *a*: (0.30662, 0.68123)
Intercept *b*: (11.554, 17.445)

Correlation:

***r*:** 0.22374
***r*2:** 0.05006
***t*:** 2.104
***p* (uncorr.):** 0.038372
Permutation *p*: 0.0376



RMA Regression

Slope *a*:	0.21208	**Std. error *a*:**	0.022388
***t*:**	9.4729	***p* (slope):**	6.6346E-15
Intercept *b*:	15.234	**Std. error *b*:**	1.4526

95% bootstrapped confidence intervals (*N*=1999):

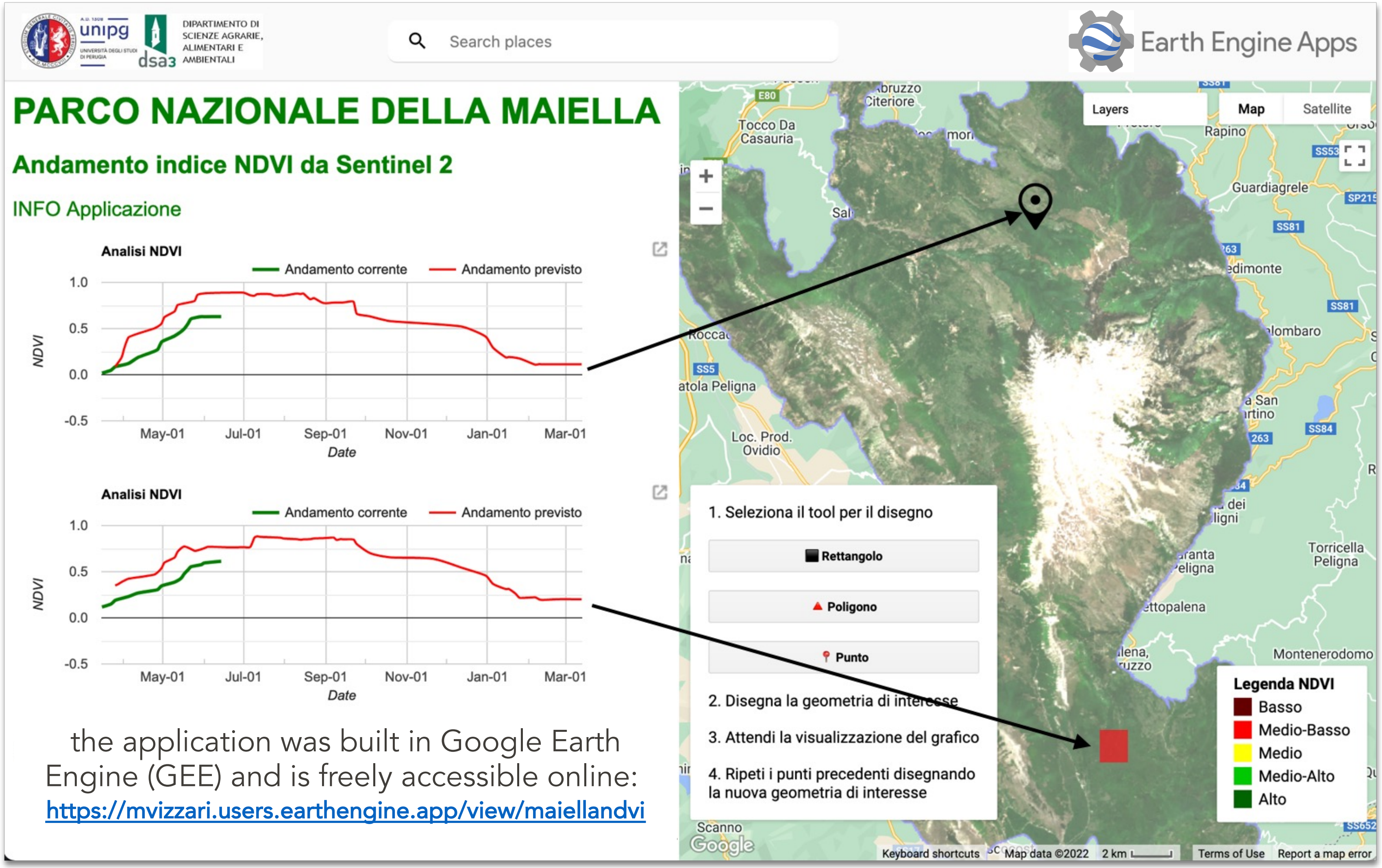
Slope *a*: (0.12469, 0.27389)
Intercept *b*: (12.793, 17.915)

Correlation:

***r*:** 0.25281
***r*2:** 0.063911
***t*:** 2.3948
***p* (uncorr.):** 0.018854
Permutation *p*: 0.0182

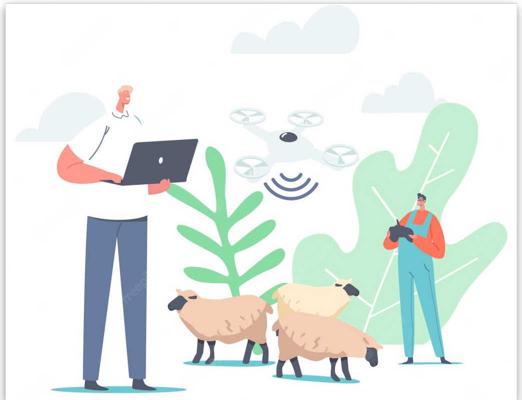
results: web-GIS tool

❖ development of a web interface for **near-real-time analysis** of the vigor and phenological phases of vegetation



the application was built in Google Earth Engine (GEE) and is freely accessible online: https://mvizzari.users.earthengine.app/view/maiellandvi

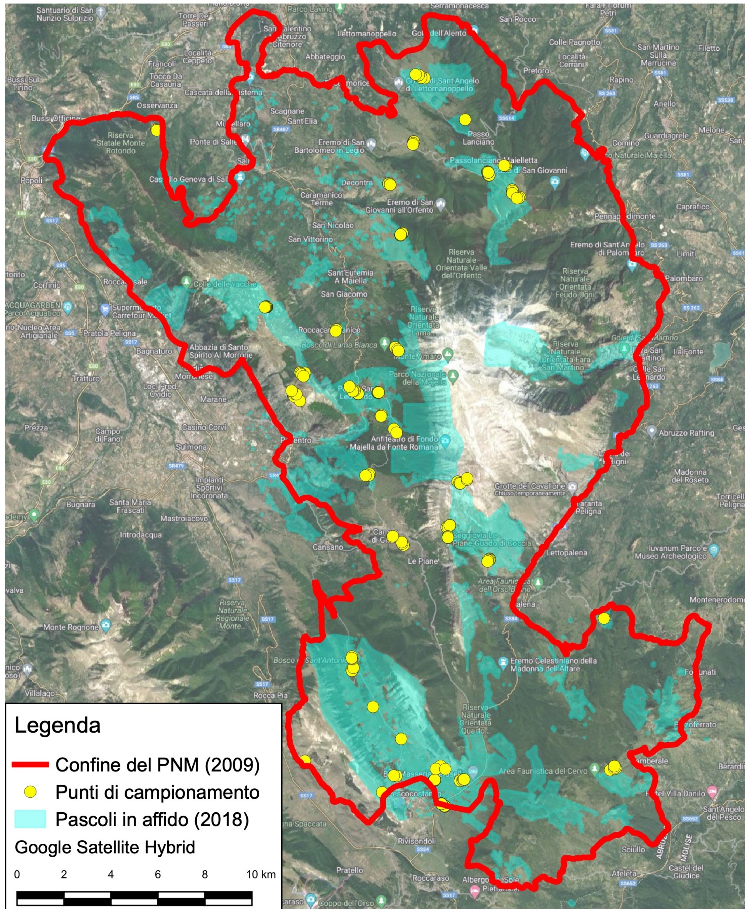
an interactive and operational tool that provides information on the current growth trend of vegetation (**green line**: the NDVI trend of the last 3 months) in comparison with the expected one, referred to today's date last year (**red line**), supporting the rational use of grazing areas

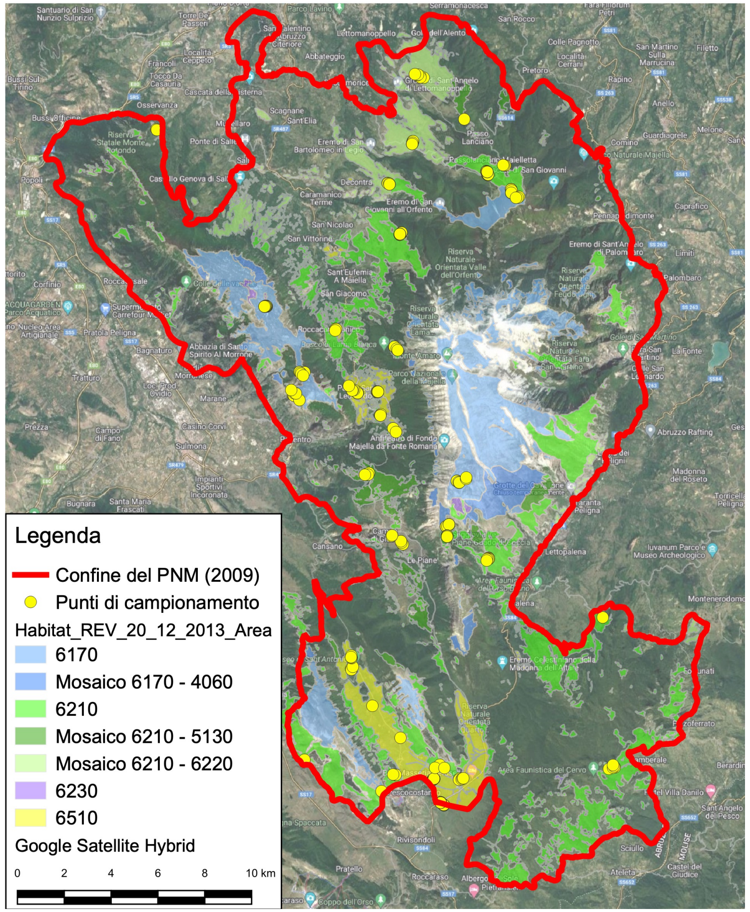


it can be used on any smartphone

results: in progress

- map of the distribution of the secondary grassland types (pastures, meadows, pasture-meadows) at the level of phytosociological alliance, scale 1:10,000
- spatialization of the appropriate animal load, for a correct grazing planning, and promotion of farmers activities, in order to halt the huge dynamic processes affecting at present large areas of the MNP





final remarks

- the understanding of secondary grasslands, and their maintenance in favorable conservation status, profit from an integrated approach, combining not only an analysis of their **biodiversity** but also the implementation of **traditional sustainable uses and practices**

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- we propose an **integrated approach** for the assessment of the appropriate animal load, that takes into account, at the same time, **classical biodiversity traits** (e.g. vegetation and Annex I habitats) and **nutritional parameters** (direct: chemical content – and indirect: pastoral value), **different scales of sampling** (field survey and remote sensing), adding some **innovative technological support** to farmers (e.g. web-GIS tools)

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- this approach allows to support the farmers/shepherds job, and to identify areas worth AND susceptible to recovery (when present), also in the present frame of climatic changes

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- this approach allows to support the farmers/shepherds job, and to identify areas worth AND susceptible to recovery (when present), also in the present frame of climatic changes

- any effort is doomed to failure if effective strategies are not adopted to bring **humans and animals** back to the territory: this implies a serious effort to emphasize **the farmers' role for active nature conservation** and a serious support to the empowerment of the local economy


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ALIMENTARI E AMBIENTALI
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thanks for your attention!