Soil Biological Quality index effectiveness at different reference scale

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Fabrizio Ungaro, Anita Maienza, Romina Lorenzetti, and Costanza Calzolari

CNR - National Research Council of Italy. Institute of BioEconomy, Florence, Italy

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QBS-ar index

The Soil Biological Quality index (QBS-ar)
associates the mesofauna community diversity to the degree of adaptation to edaphic life.

Other methods	QBS_ar
Based on number of individuals in the sample	Based on the **structure of the biocenosis,** more stable and more easily linkable to the level of degradation or maturity of a soil.
Classification at species level	species level not required

- more than 20 years of application
- resulted a user-friendly, rapid and low-cost method sensible to catch soil quality changes even in the short-term.
- In EJP SOIL projects QBS-ar is evaluated in order to be used for **modelling and mapping soil biodiversity in EU**
- **mostly applied at farm or local scale** for assessing soil quality in relation to different crop management practices or disturbance level

Need of an improvement of knowledge about the **main environmental drivers behind QBS-ar** and how they could change **at the different reference scales**, for a spatial modelling of QBS-ar

Aim

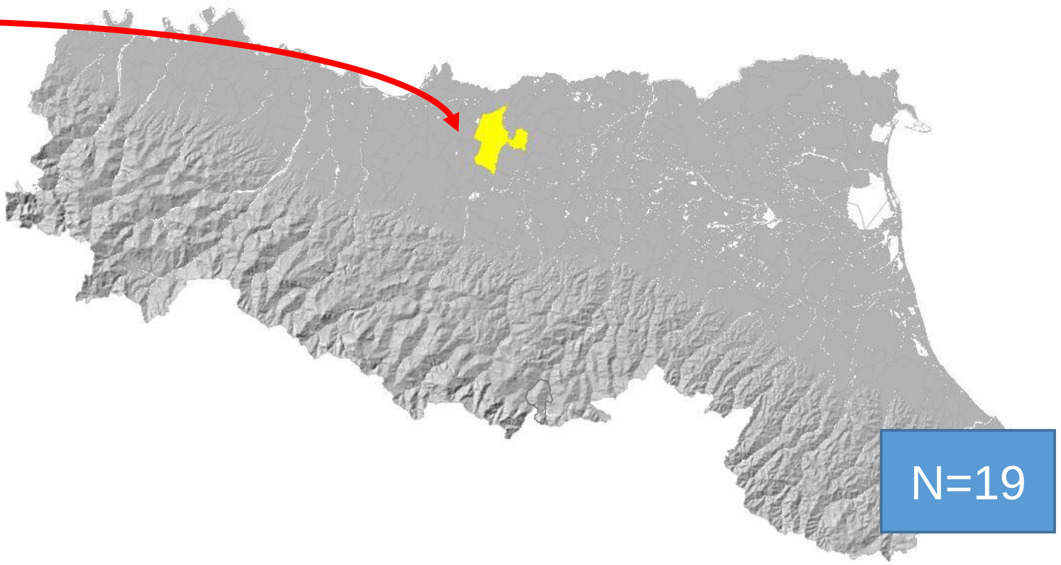
To analyse the results of different studies undertaken at different scales in the Emilia Romagna Region (N Italy) in order to compare the main driving factors behind QBS-ar both at a local and regional scale, highlighting how they could affect mapping activities

Investigated areas

- This contribution presents the results of different studies undertaken at different scales in N Italy:

Emilia Romagna Region (22.510 km^2)

Municipality of Carpi (extension of ca. 132 km^2)



QBS-ar drivers at local scale: the case study

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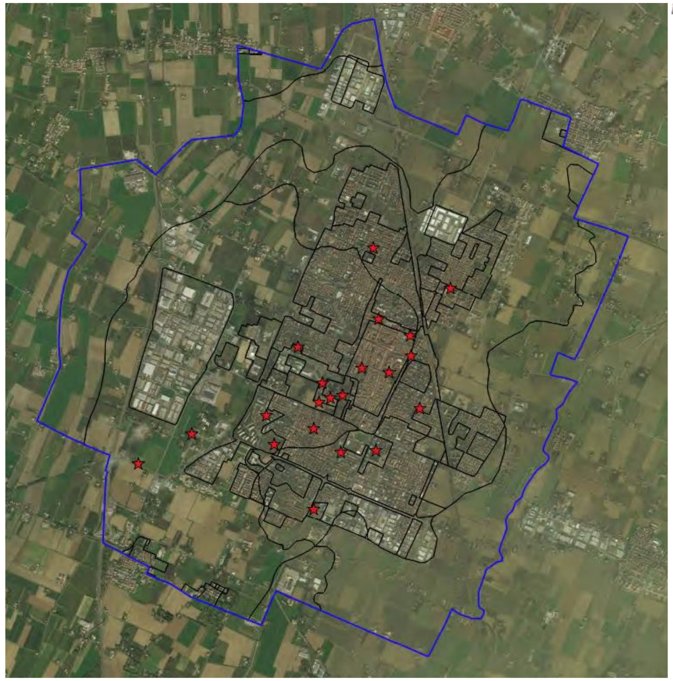
Original article

Assessment of joint soil ecosystem services supply in urban green spaces: A case study in Northern Italy

F. Ungaro, A. Maienza *, F. Ugolini, G.M. Lanini, S. Baronti, C. Calzolari

Institute of Bioeconomy, National Research Council (IBE CNR), Via Madonna del Piano 10 Sesto Fiorentino, 50019 Firenze, Italy



✓ 19 urban soils, selected for microbiological and soil microarthropods sampling and hydrological measurements, as representative of the different types of green areas and of the main soils:

❖ 13 in urban parks (UP), with high (UPH) (a) or with low (UPL) (b) vegetation density;
❖ 3 in roadside green (RG) (d);
❖ 3 in urban and peri-urban agricultural fields (AR) (c)

Urban soil properties

Characteristics of soils of urban and peri-urban areas:

- extreme heterogeneity.
- more or less pronounced anthropic disturbance,
- presence of non-soil materials within the soil profile impermeable materials sealing the soil surface.

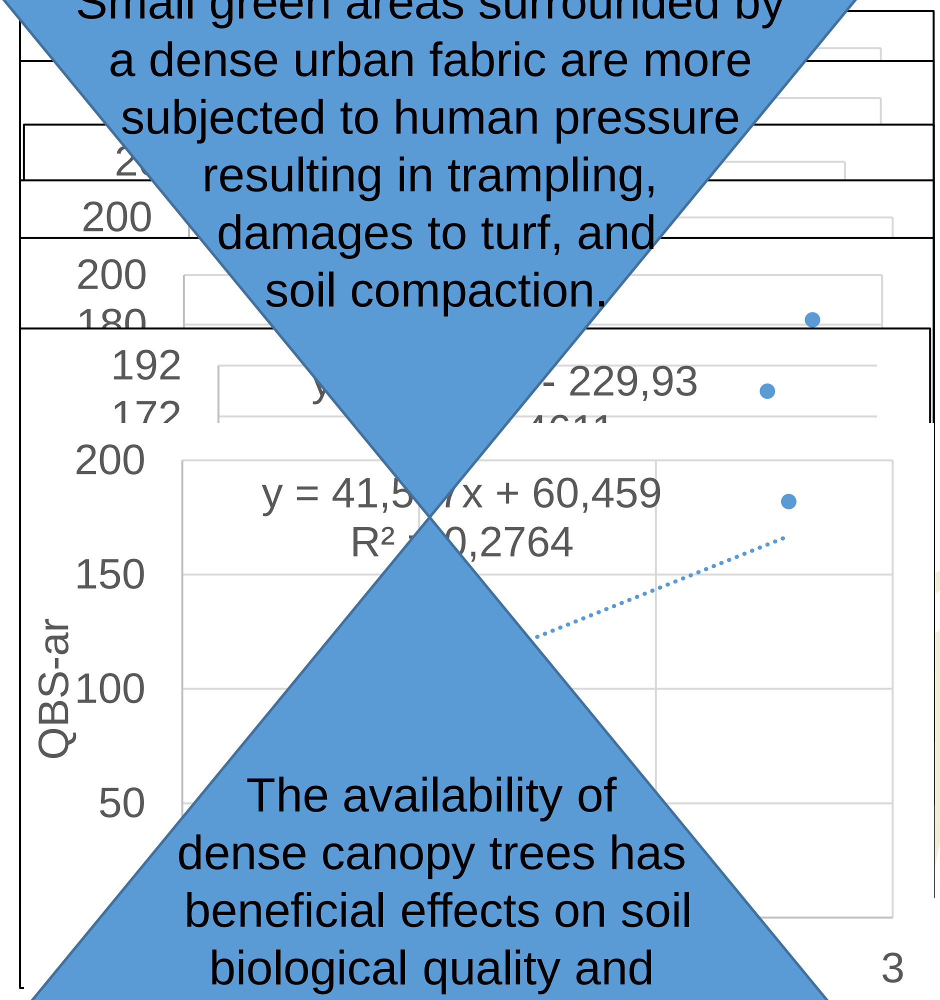
All these factors modify the quality of urban soils and their functions.

In the **case study**:

- ✓ sand and $CaCO_3$ content are affected by the level of soil disturbance due to mixing up $CaCO_3$ enriched subsoil Bk horizons or presence of non-soil material (Calzolari et al.. 2020),
- ✓ SOC is on average higher in urban green areas as compared to agricultural soils (no tillage activities in urban green areas)
- ✓ Saturated hydraulic conductivity (Ksat) results lower in urban green areas than in agricultural ones, although not significantly. Usually, urban soils are highly subjected to trampling which limits infiltration

QBS-ar drivers at local scale

- At a local scale, the trend of the QBS-ar index is affected by different levels of disturbance, showing:
  - a significant negative correlation with anthropic pressure , here:
    - ✓$CaCO_3$ (negative correlation; R^2 0.44, $p < .005$)
    - ✓degree of sealing of the surrounding areas (negative correlation; $R^2 = 0.35$, $p < .005$)
    - ✓extension of green area (positive correlation; $R^2 = 0.57$, $p < .001$)
  - a significant negative correlation with vegetation degradation status
    - ✓LAI (positive correlation; $R^2 = 0.77$, $p < .0001$)
    - ✓canopy cover (positive correlation; $R^2 = 0.56$, $p < .005$)
  - and a good correspondence with soil biological parameters
    - ✓BFI (soil biological quality index) ($R^2 = 0.46$, $p < 0.05$)
    - ✓C/N ($R^2 = 0.28$, $p < 0.05$)



Small green areas surrounded by a dense urban fabric are more subjected to human pressure resulting in trampling, damages to turf, and soil compaction.

The availability of dense canopy trees has beneficial effects on soil biological quality and QBS is particularly sensitive to this

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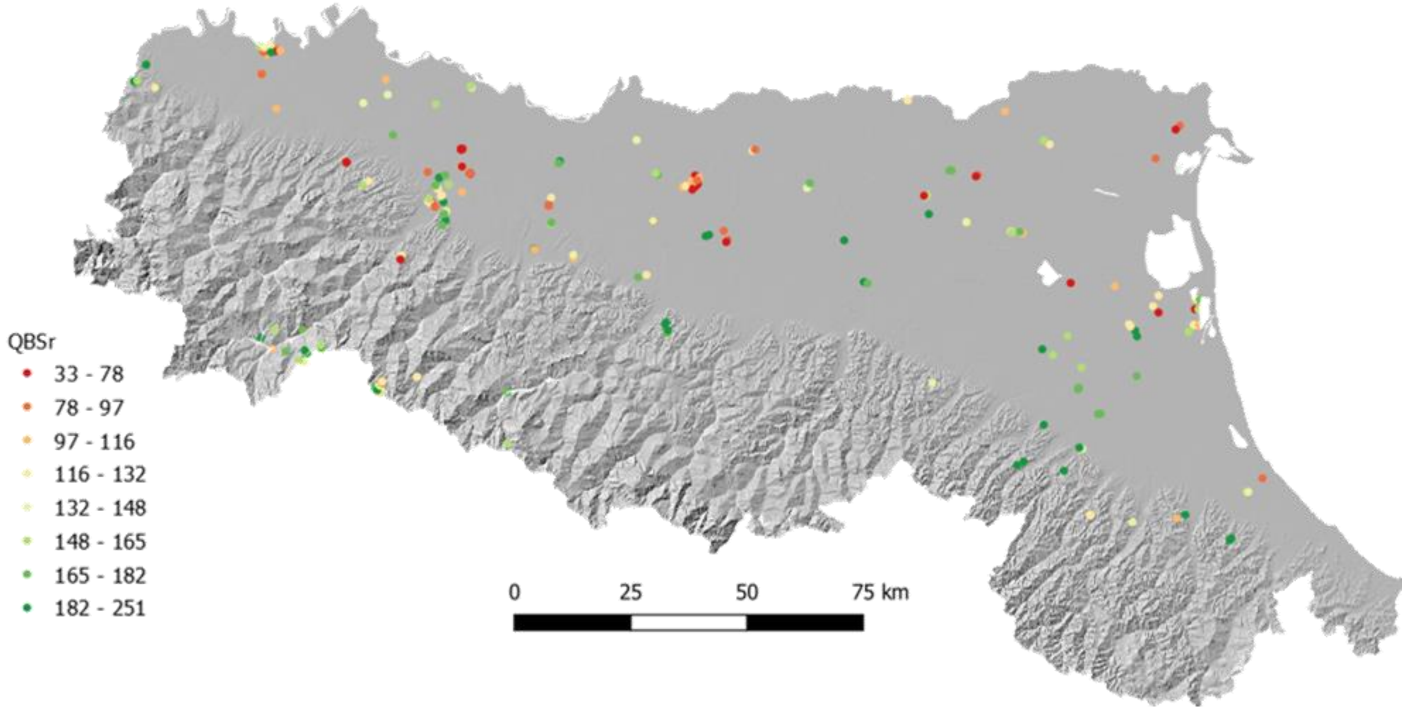
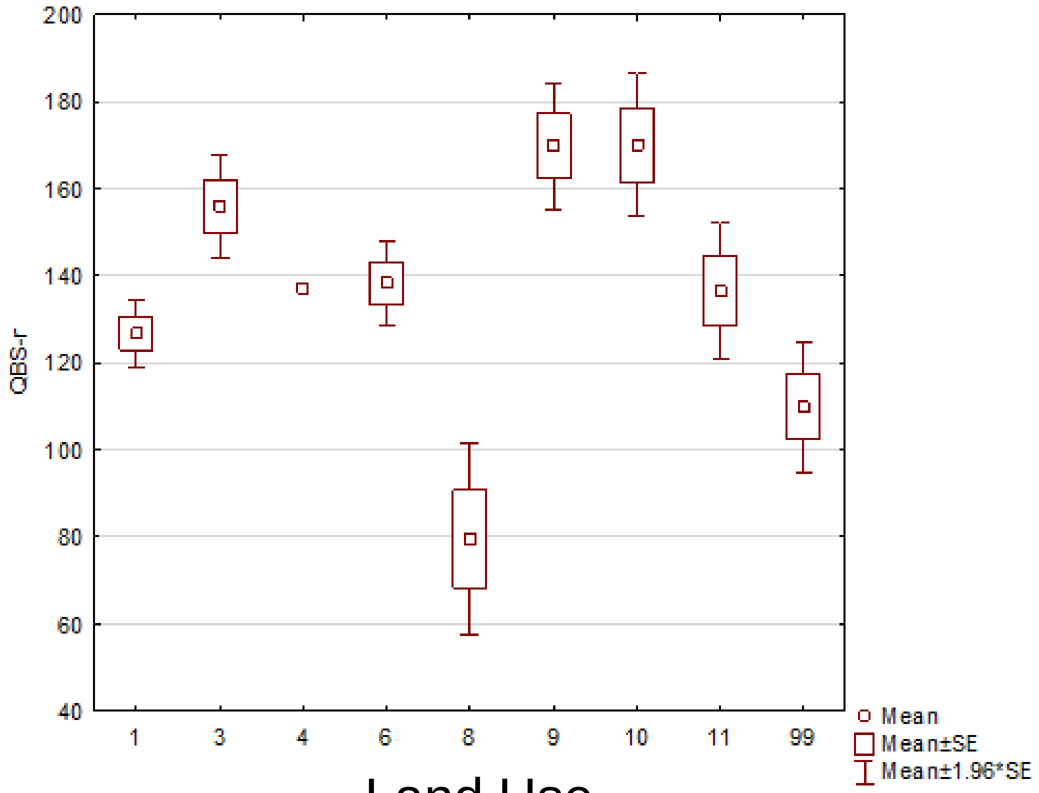
QBS-ar drivers at regional scale





Land Use

- At regional scale, a tentative DSM approach was used to infer the QBS-ar index spatial distribution.
- Machine learning algorithms (random forest) were used using soil parameters, remote sensing data, data from DEM and Land Use.

1 arable land
3 orchards
4 natural vegetation
6 woods
8 outcrops
9 vineyards *
10 chestnut trees
11 pasture meadows
99 other

** Samples were collected in experimental vineyard where conservative practices as greening were applied*

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QBS-ar drivers at regional scale

Correlations with SOIL parameters. Marked correlations are significant at p < ,05000 N=330

	BD	OC	ph	ksat_log10	skel	clay	sand	wc1500	wc333
QBS-ar	0.1377	-0.0169	-0.1054	-0.0523	0.0805	-0.0430	0.0140	-0.0088	0.0067
	p=0.012	p=0.760	p=0.056	p=0.344	p=0.144	p=0.436	p=0.801	p=0.873	p=0.903

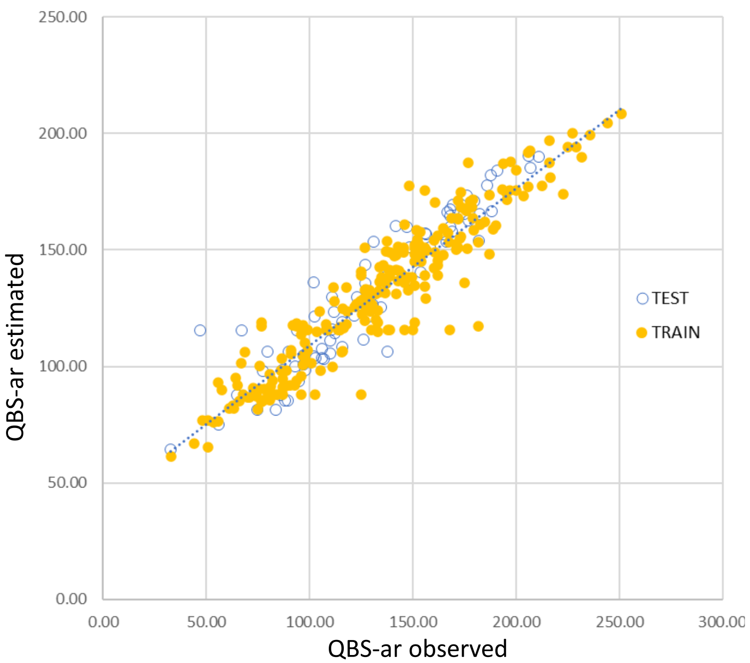
	Dem_100m	Erosion	mrivbf	twi
QBS-ar	0.1167	0.2317	-0.2159	-0.2538
	p=0.034	p=0.000	p=0.000	p=0.000

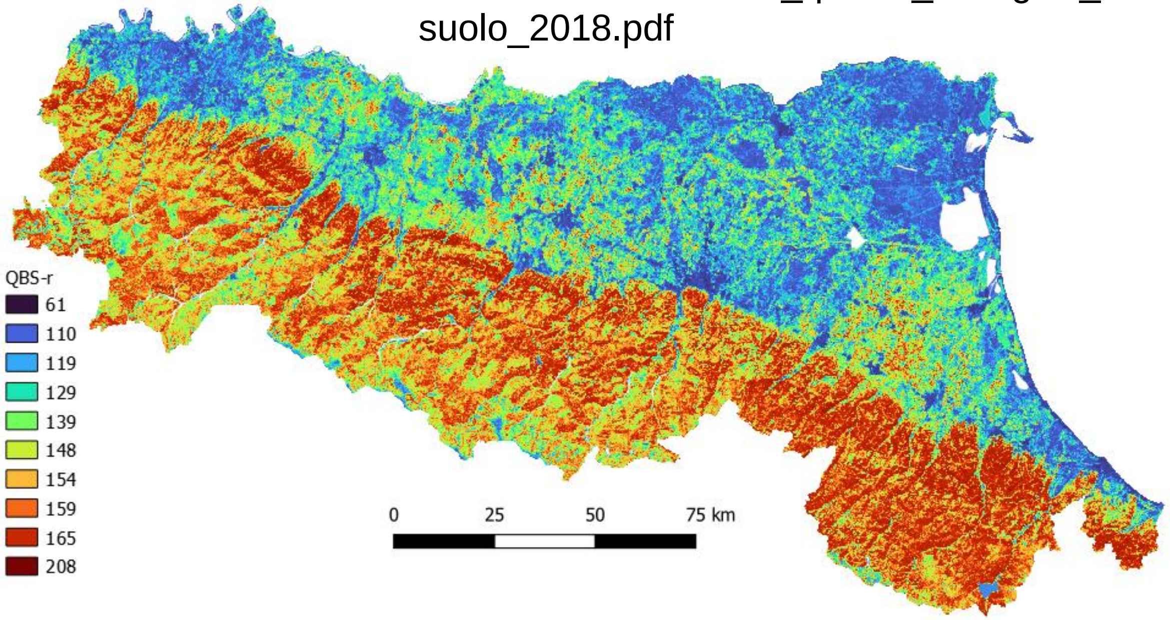
	NDVI_1520_r	NDVI_5	NIR	evi	RED	SWIR	gfc_tcov_r
QBS-ar	0.2882	0.2438	0.2487	0.3279	0.1751	-0.0239	0.1121
	p=0.000	p=0.000	p=0.000	p=0.000	p=0.001	p=0.665	p=0.042

QBS-ar map at regional scale

https://ambiente.regione.emilia-romagna.it/it/geologia/suoli/pdf/REPORT_qualita_biologica_suolo_2018.pdf/@@download/file/REPORT_qualita_biologica_suolo_2018.pdf

Covariate	LN nodepurity	
bd_RER	1512.5821	3.52%
clay_RER	1430.8741	3.33%
corg_RER	1462.8917	3.40%
cstock_RER	1463.2918	3.40%
dem_rer100	1996.6477	4.64%
eroatt_rer	2284.065	5.31%
gfc_tcov_rer	1593.7456	3.70%
evi_rer	2708.0955	6.29%
landuse_recl_rer	745.103	1.73%
mrivbf_rer	1770.3841	4.12%
ndvi5_rer	1756.9185	4.08%
ndvi1520_rer	2448.7857	5.69%
nir_rer	1933.8755	4.50%
nort_rer	1792.3712	4.17%
red_rer	2133.652	4.96%
ph_RER	1629.2967	3.79%
poro2_RER	1429.4734	3.32%
psie_RER	1275.1594	2.96%
swir_rer	1722.9878	4.00%
twi_rer	1862.1712	4.33%
vdepth_rer	1800.5471	4.19%
sand_RER	1236.9643	2.88%
silt_RER	1768.7101	4.11%
skel_RER	598.6655	1.39%
wc333_RER	1379.8217	3.21%
wc1500_RER	1283.9934	2.98%





Most important parameters in QBS-ar prediction:
- -Eroatt } Missleading correlation
- -DEM
- -EVI
- -NDVI
- -NIR
- -RED

} Information about vegetation status and sealing

Machine learning algorithm highlighted the relevance of vegetation spectral indexes from remote sensing as predictors of QBS-ar

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QBS-ar drivers from local scale to regional scale

LOCAL DRIVER	Local indicator	Applicability of local indicator at regional scale	Regional possible indicators	Does it work ?
Anthropic pressure	$CaCO_3$	No. Different meaning (lithology)	LAND USE	Yes
	sealing degree	No. Not reproducible at the reference scale		
	extension of green area	No. not reproducible at the reference scale		
Vegetation status	LAI	Yes	NDVI and other vegetation indeces	yes
	canopy cover	Yes		
Pedological and Pedoclimatic condition	--	Yes	Soil texture...	no
			DEM	yes
			topography	yes
Other soil biological parameters	biological fertility index BFI	--	OC	no
			BD	no
	C/N	Yes	C/N	Work in progress

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Conclusions

1. Common correlation: disturbance degree and vegetation cover
2. Unexpected not significant correlation with most of soil properties (BD, SOC..)
3. Difficulties to upscale and represent the local drivers due to the minimum cell dimension of the input and output (e.g. Anthropic disturbance: extension of area , soil sealing %)
4. different meaning of some drivers (e.g. $CaCO_3$, BD)
5. Importance of the sampling design and of the representativeness of sampled soil (e.g. vineyard case)

Although the good metrics of the validation, the map must be considered a provisional map which could represent a basis for validating hypothesis on the mechanisms driving biodiversity indicator patterns at regional scale

Thanks for your attention!