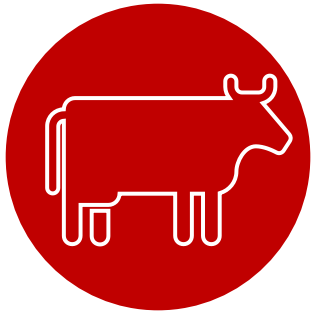
ECOSYSTEM SERVICE OF EROSION PREVENTION: A REMOTE SENSING ASSESSMENT IN GRASSLAND-BASED MOUNTAIN DAIRY FARMS IN NORTH-EASTERN ITALY

S. Da Re[1], F. Joly[2], C. Pornaro[1], M. Berton[1], E. Sturaro[1]

[1]University of Padua, DAFNAE, Viale dell'Università 16, 35020 Legnaro, Italy
[2]University Clermont Auvergne, INRAE, VetAgro Sup, UMR Herbivores, Theix, 63122 Saint-Genès Champanelle, France



Mountain Grassland and Livestock Joint Conference
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Introduction

MOUNTAIN GRASSLAND-BASED DAIRY FARMS →

" Extensive livestock systems characterized by low-input practices and the creation and maintenance of semi-natural habitats (eg. meadows and pastures) in less favorable and less accessible areas"
(Rodríguez-Ortega et al., 2014; Faccioni et al.,2019)

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ECOSYSTEM SERVICES →

"All the direct and indirect benefits that ecosystems provide to humanity"

Millennium Ecosystem Assessment Project

Introduction

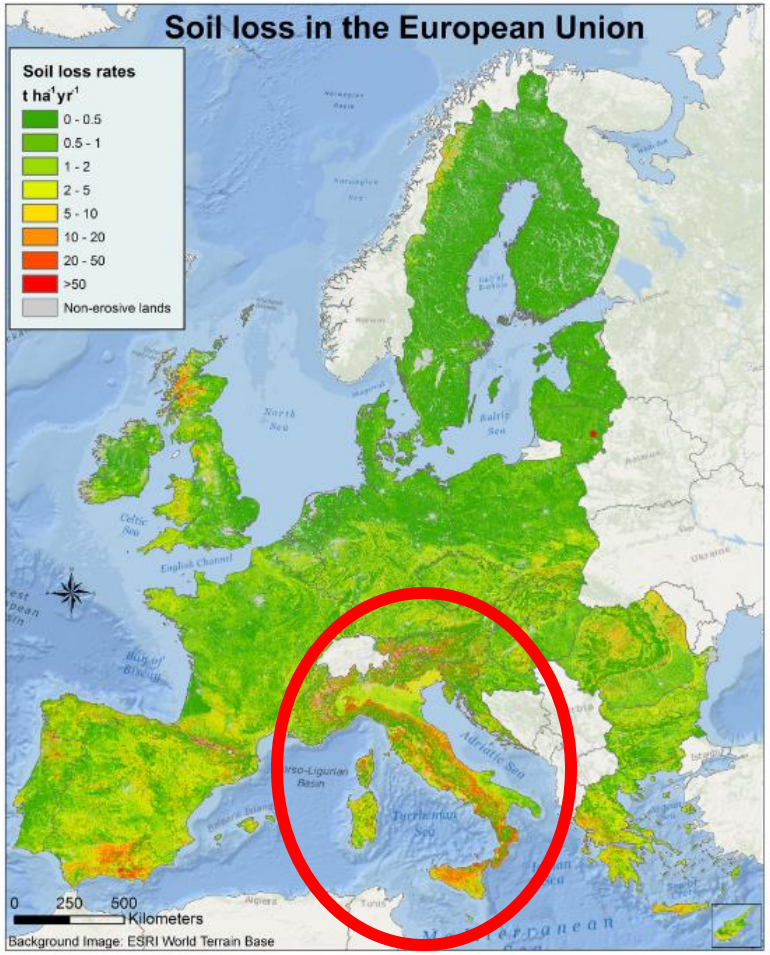

Fig. 2. Map of soil loss rates in the European Union (Reference year: 2010) based on RUSLE2015.

WHY SOIL EROSION PREVENTION?

Italy has the highest soil loss rate in EU, with an average of 8.46 t * ha^{-1} * year $^{-1}$ (24,13 % of the total)

According to Panagos et al., 2015 the average rate of soil formation in Europe of 1.4 t *ha^{-1} * year $^{-1}$

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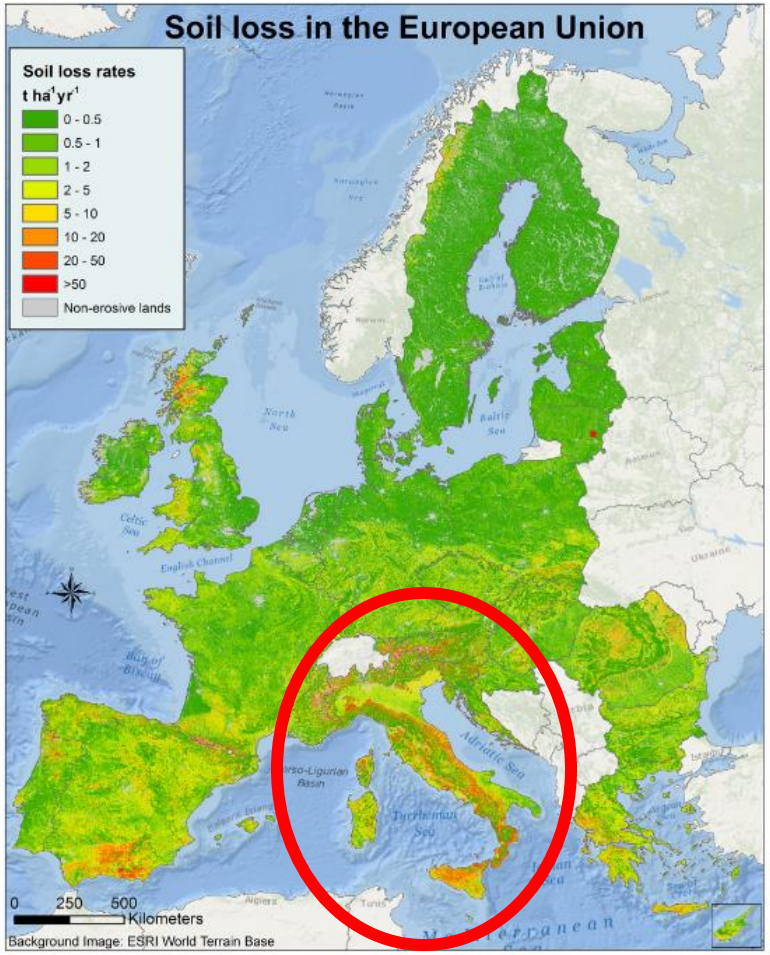

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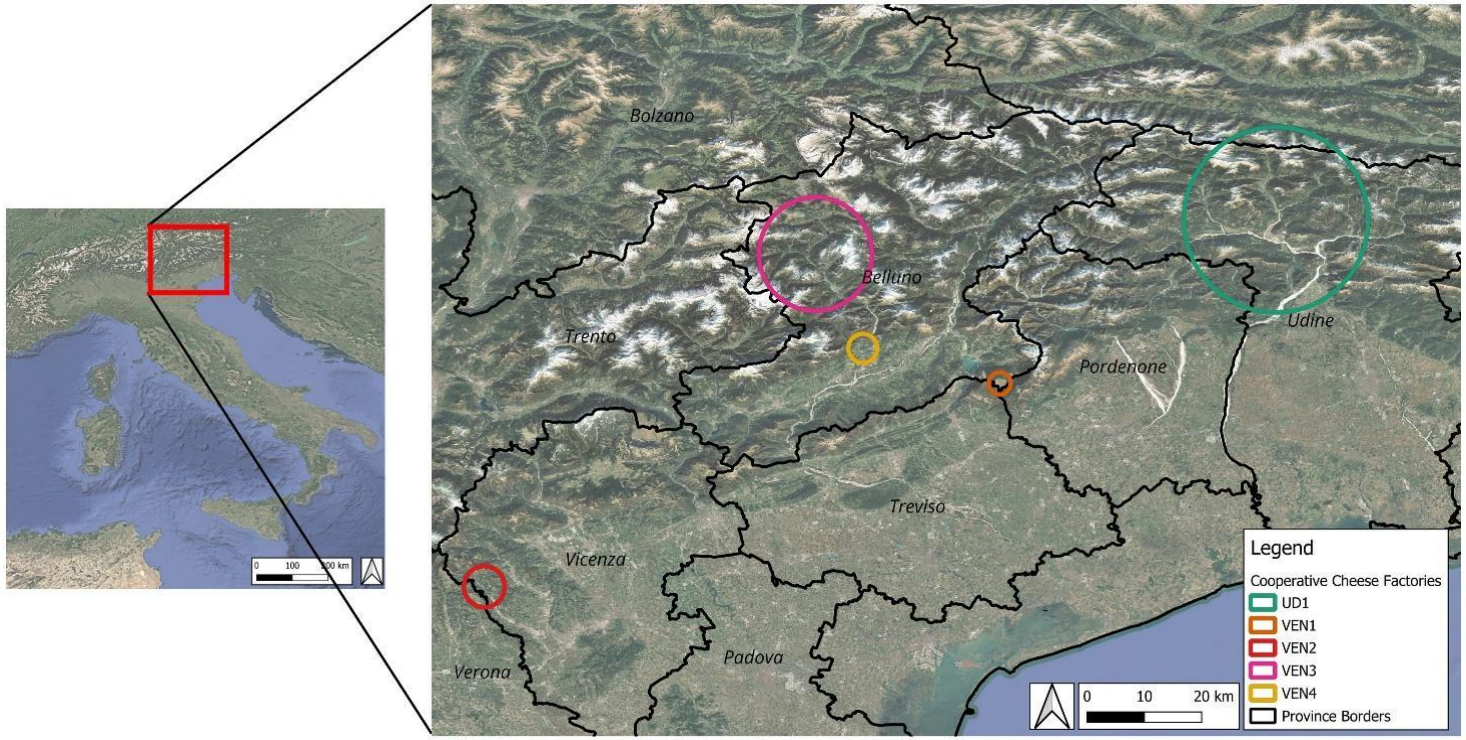
Research Question

Does the management intensity of dairy farms affect soil erosion in mountain grasslands?

Materials and Methods: Study Area

- 38 mountain grassland-based dairy farms, organized into 5 different local Cooperative Cheese Factories
- The Life Cycle Assessment data were taken from a 2021 study conducted by Berton et al. referring to the year 2017



VARIABLE	MEAN	STANDARD DEVIATION	MIN	MAX
Farm area (Ha)	35	27	5	107
Grassland (Ha)	28	23	5	100
Cropland (Ha)	1	3	0	12
Milk yield (kg FPCM*LU^{-1} year^{-1})	4837	1202	2464	7335
Dairy Cows (LU)	27	20	5	86
Yearly Grazing days Dairy Cows	87	84	0	300
Barn Altitude (m a.s.l.)	689	297	280	1375

Materials and Methods: Model

Revised Universal Soil Loss Equation (RUSLE; Renard et al., 1997)

$$E = R \times K \times C \times LS \times P$$

E: annual average soil loss ($t\ ha^{-1}\ yr^{-1}$),

R: rainfall erosivity factor ($MJ\ mm\ ha^{-1}\ h^{-1}\ yr^{-1}$)

K: soil erodibility factor ($t\ ha\ h\ ha^{-1}\ MJ^{-1}\ mm^{-1}$)

C: cover-management factor (dimensionless)

LS: slope length and slope steepness factor (dimensionless)

P: support practices factor (dimensionless)

From the ESDAC we obtained data for :

- **Monthly R factor**
- **K factor**
- **LS factor**
- **P factor**

JOINT RESEARCH CENTRE
EUROPEAN SOIL DATA CENTRE (ESDAC)

Materials and Methods: Model

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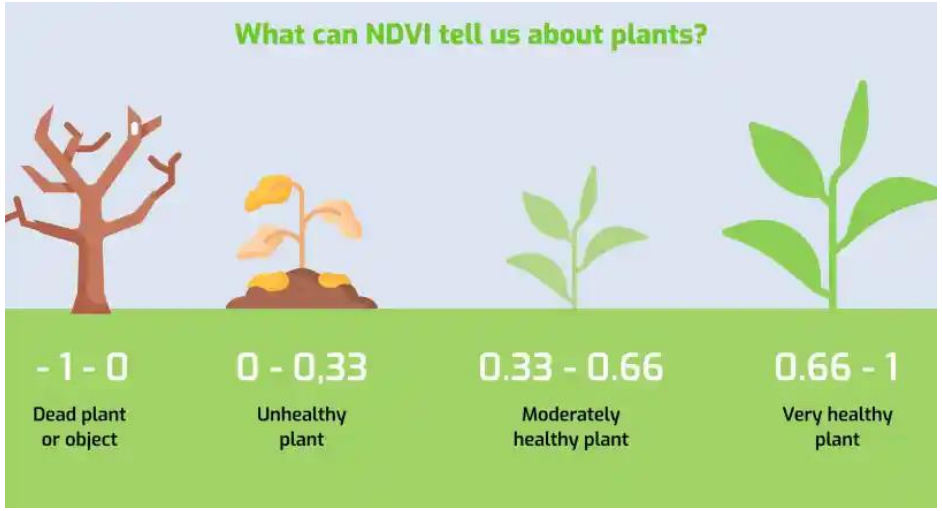
The Normalized Difference Vegetation Index (NDVI) is calculated using the spectral bands (band 4 and band 8) obtained by Sentinel-2 satellites network from ESA (Copernicus Program) with a pixel resolution of 10 m²

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} = \frac{(B8 - B4)}{(B8 + B4)}$$



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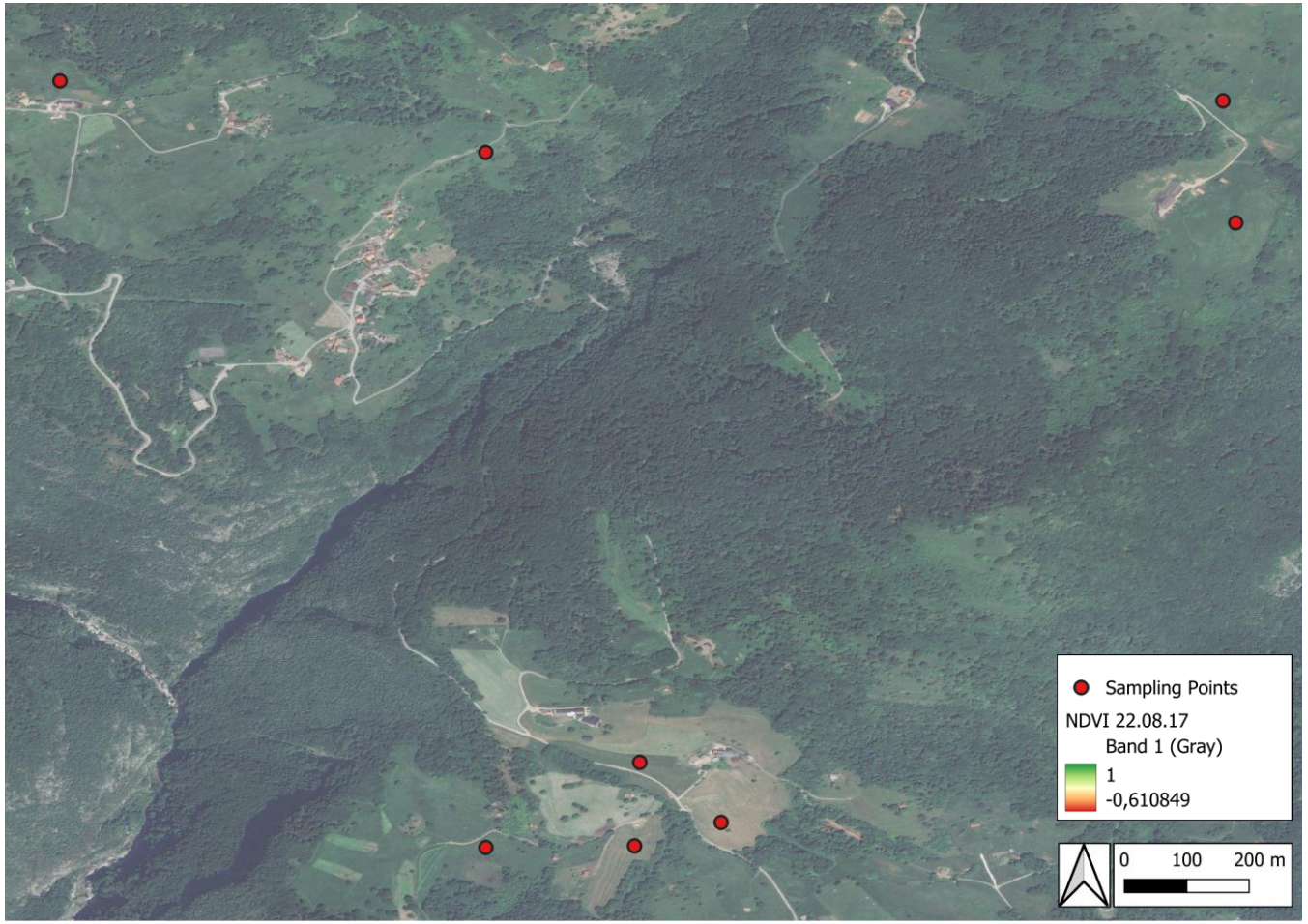

For each of the 38 farms, three plots were selected, corresponding to meadows and pastures where Pornaro et al. had conducted a sampling of botanical diversity in the summer of 2017, published in 2021

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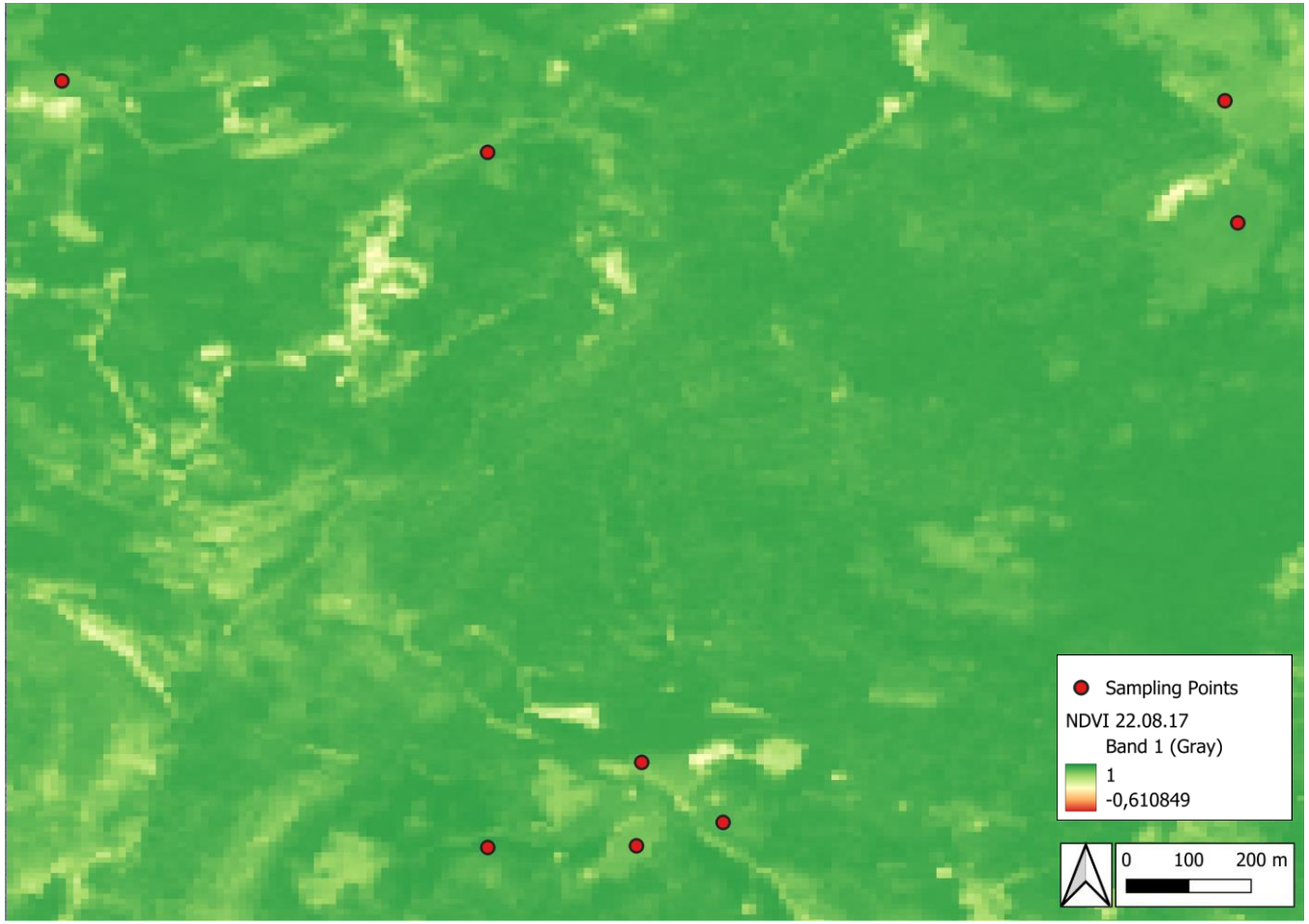

All available NDVI images for the year 2017 were downloaded from the Copernicus Sentinel-2 satellite network, using cloud and snow filters

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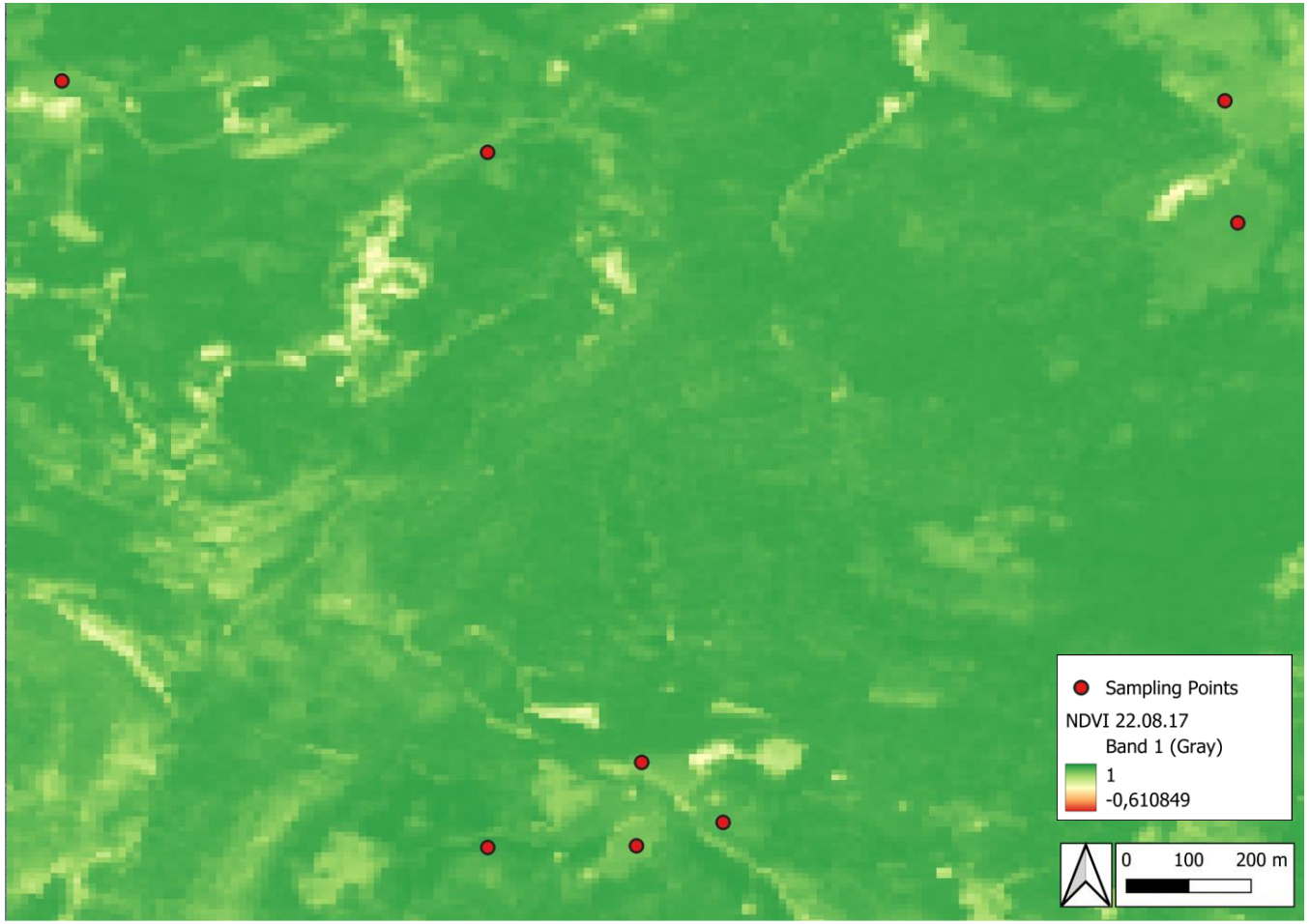

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The NDVI values were associated with the corresponding plots and used to calculated the C-factor

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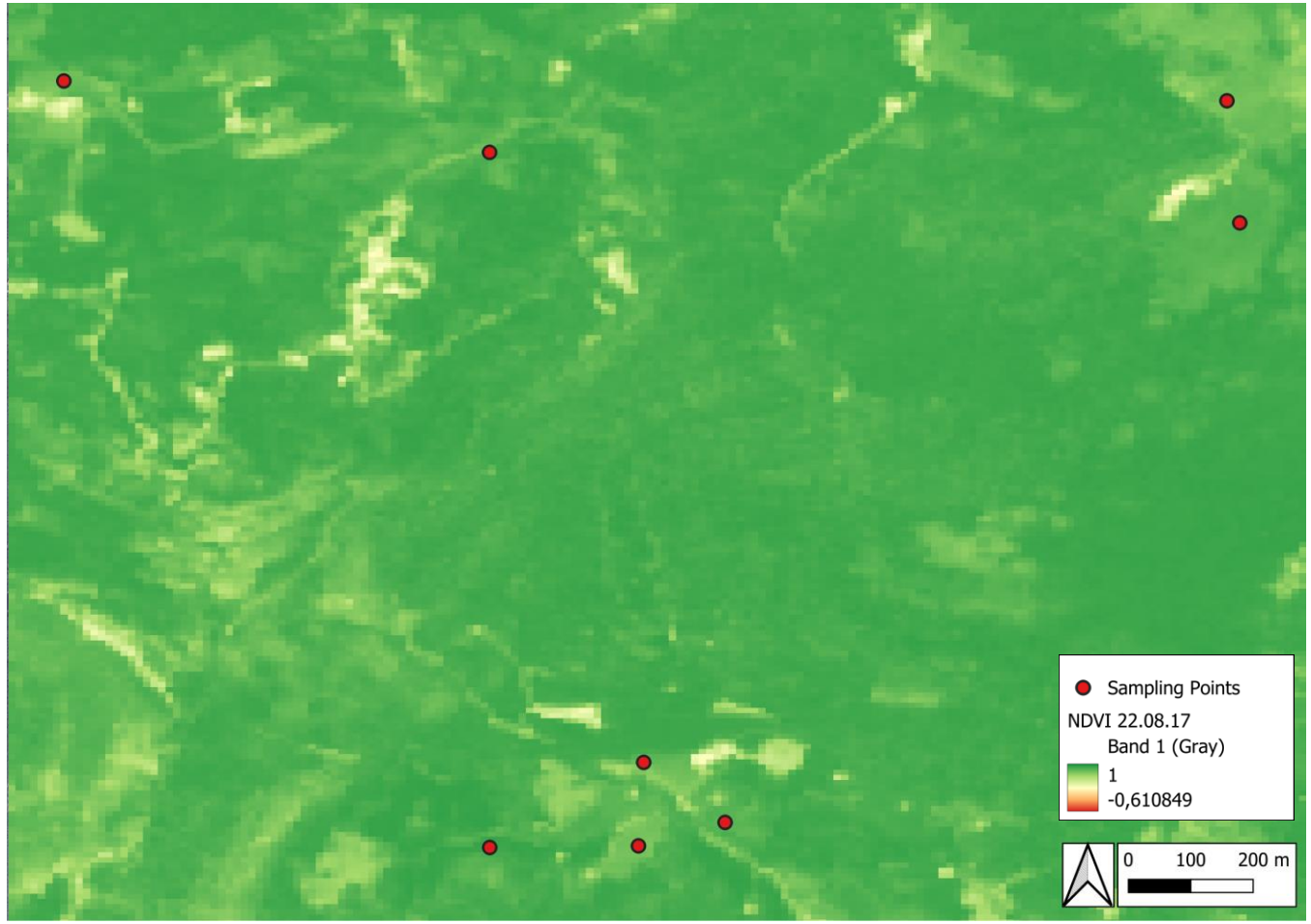

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Subsequently, the C-factor values were used to calculate a monthly average C-factor and, consequently, the total monthly amount of soil loss in each plot

Materials and Methods: Statistical Analysis

Generalized Linear Mixed Models (GLMM)

RStudio

Beta distribution

C Factor ~ 19 Predictors + (1 | Sampling_Point)

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PREDICTORS	EXAMPLES	SOURCE
Climate and Geomorphology	Temperature, Precipitation, Altitude, Slope	INGV; AGRI4CAST Resources Portal – Gridded daily agro-meteorological data in Europe

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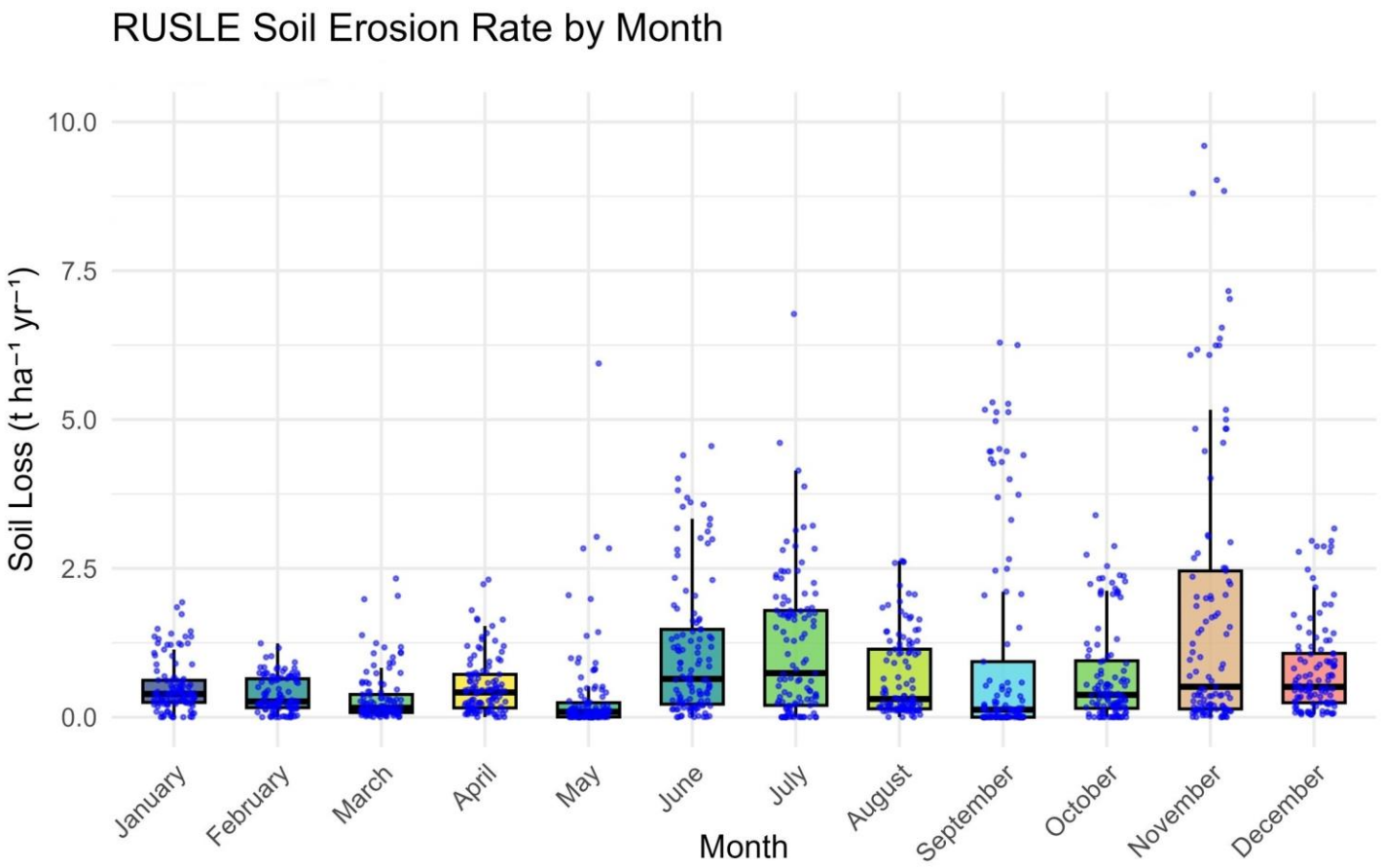
Biodiversity	Number of plant species	Botanical samplings from Pornaro et al., 2021
Management intensity	Fertilization rate, Self Sufficiency, Milk Yield	LCA data from Berton et al., 2021
Emissions	GWP (Greenhouse gasses emissions)	

Results and Discussion



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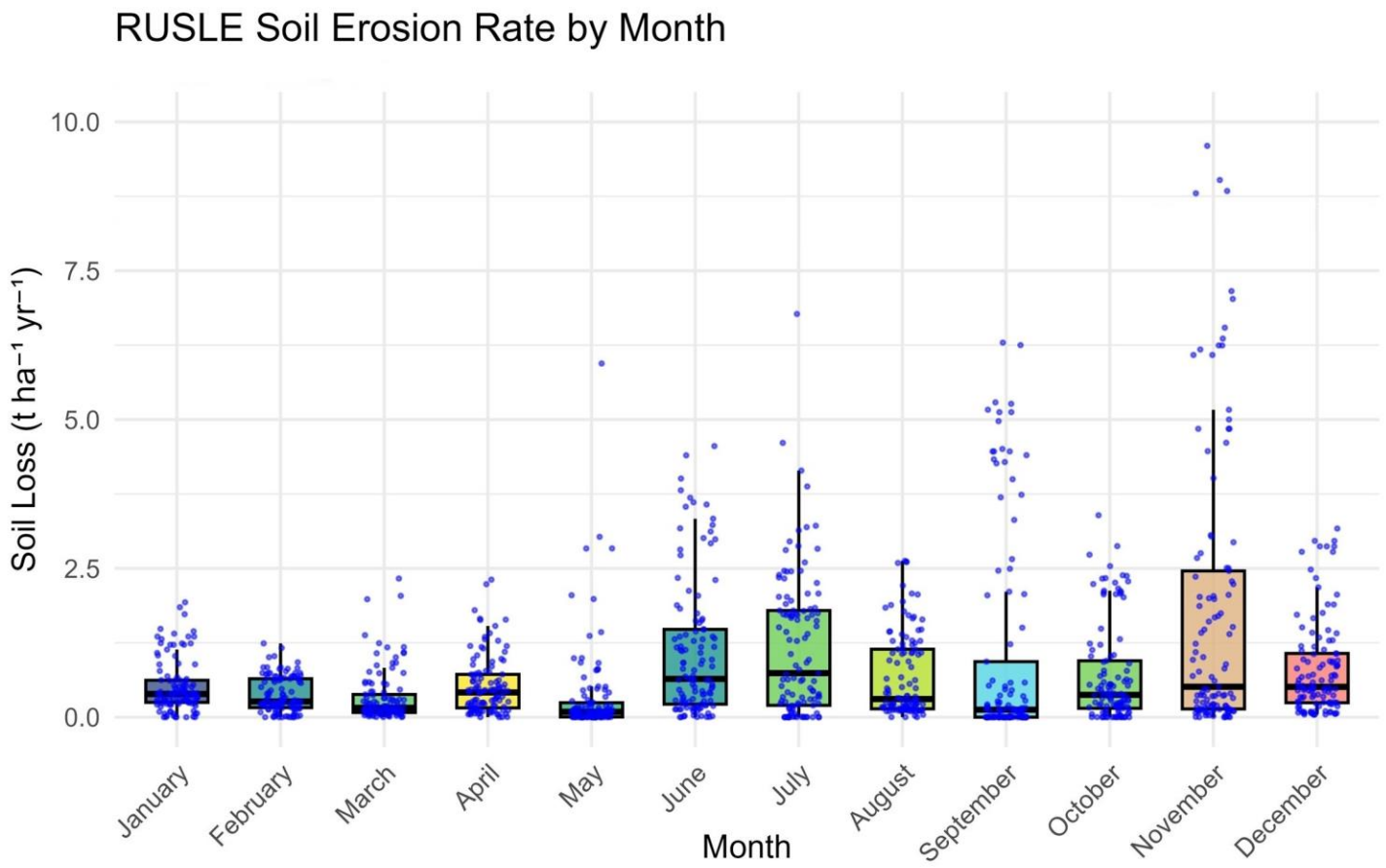

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- **Min soil loss in the plots = 0,14 t ha^{-1} year^{-1}**
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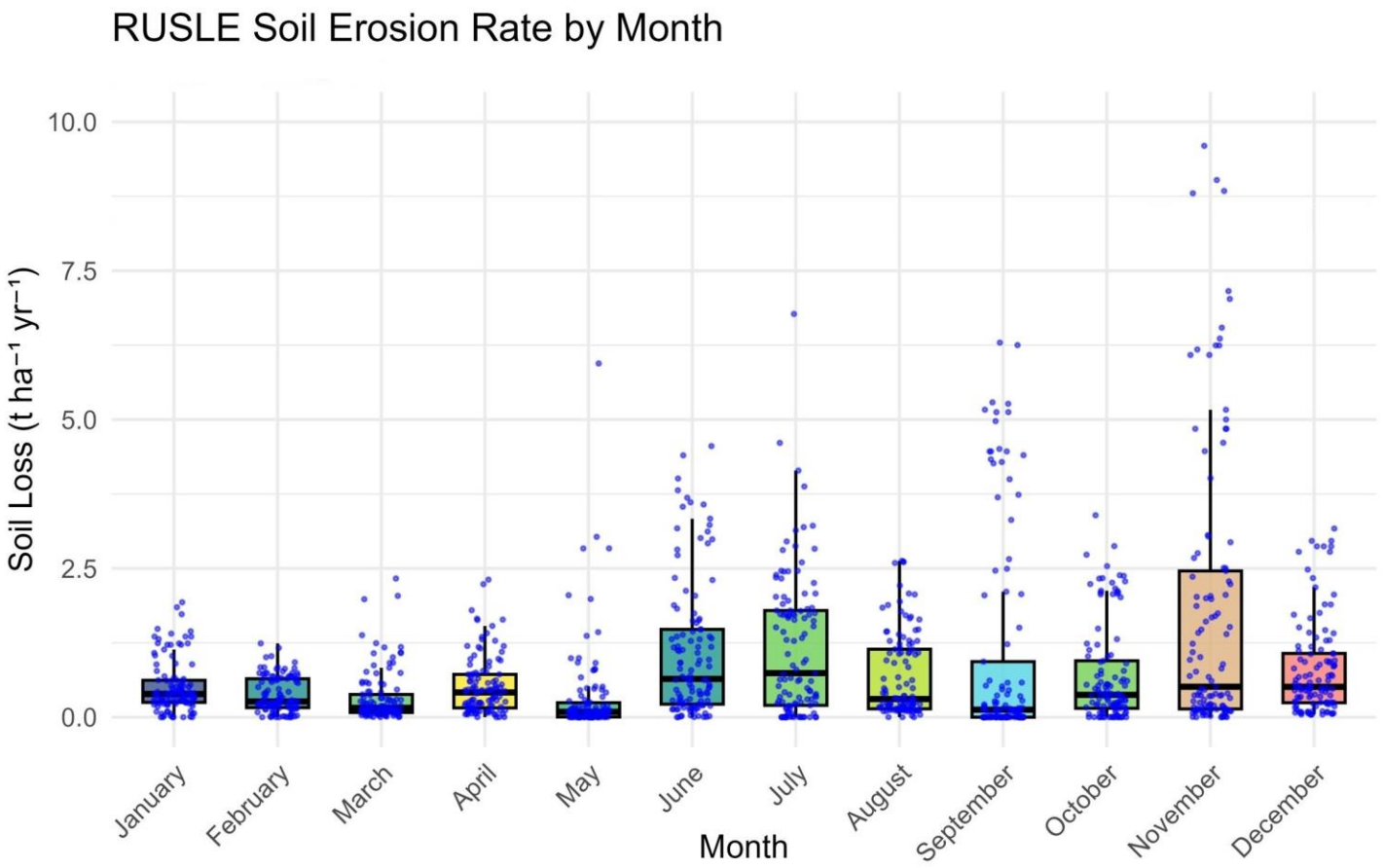

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- Min soil loss in the plots = 0,14 t ha^{-1} year^{-1}
- Max soil loss in the plots = 85.28 t ha^{-1} year^{-1}
- The month with the highest erosion rate is November, with an average of 1.67 t ha^{-1}
- The month with the lowest erosion rate is February, with an average of 0.28 t ha^{-1}

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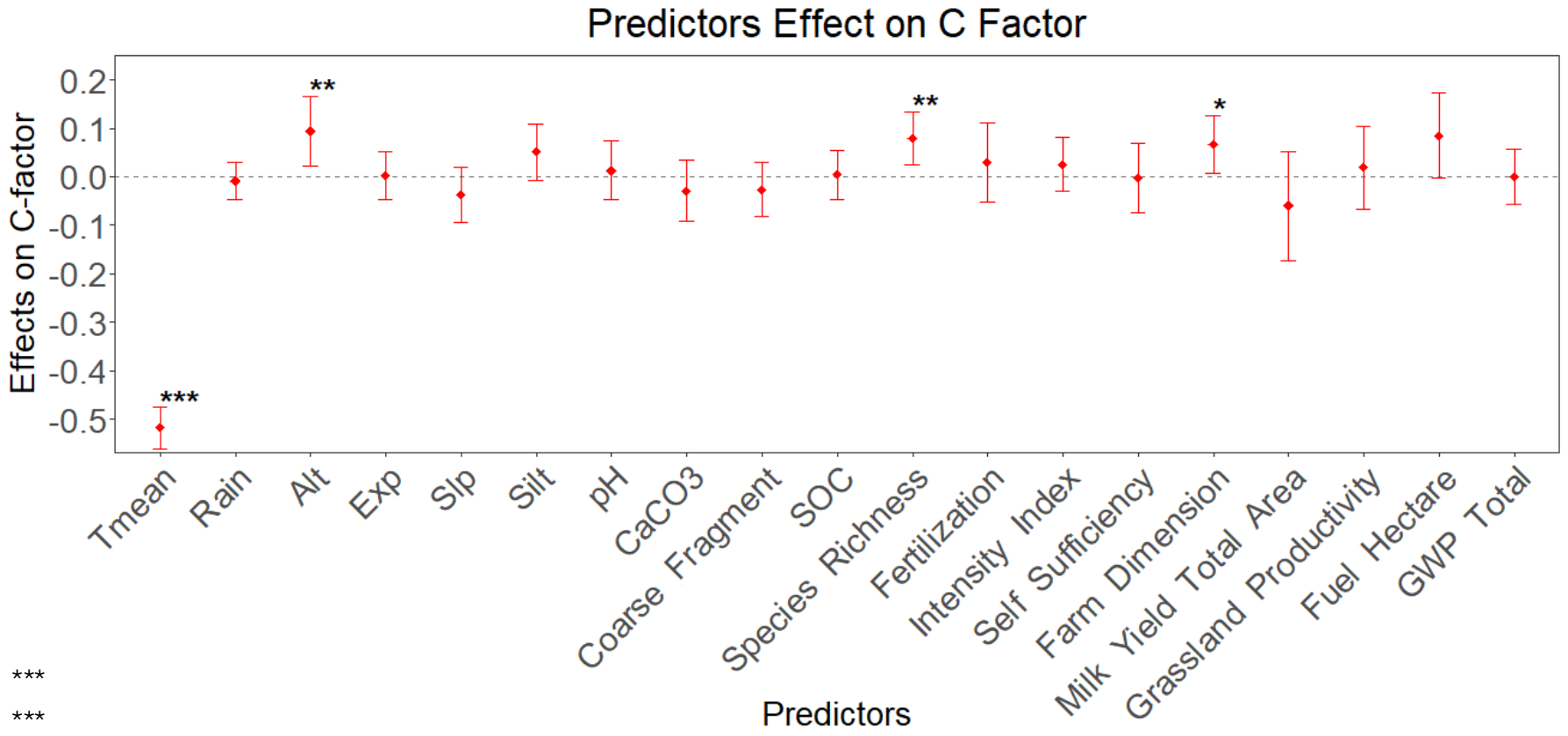

ANOVA TABLE				
Predictor	Chi square	DF	P	
Intercept	10183.75	1	< 0.001	***
Tmean	560.51	1	< 0.001	***
Alt	6.73	1	0.01	**
Species Richness	8.36	1	0.004	**
Farm Area	4.80	1	0.03	*

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- The intensity of farming practices remained within limits that do not increase the risk of soil erosion, suggesting its potentially active role in land management.
- Differences among farms may depend on their size, as larger farms can be more difficult to be homogeneously managed, with smaller farms allowing for closer monitoring of the entire area.

Conclusions

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Conclusions

- The level of management intensity identified by our analysis was generally balanced in these agroecosystems in terms of ESEP.
- However, variations in the C factor were significantly related to climatic, geomorphological, and biodiversity variables, suggesting that future studies should adopt a broader approach to better support erosion prevention practices.
- Overall, the indicators used in this study provided useful first-step information for assessing ecosystem services related to soil erosion prevention and the role of mountain grassland-based dairy systems.

Sebastiano Da Re
(sebastiano.dare@phd.unipd.it)

THANK YOU FOR YOUR ATTENTION