THEME 2

Climate and spatio-temporal variations of soil organic carbon in Mediterranean cropping systems and the influence of climate change on soil physical qualities

Pellegrini S., Agnelli A.E., Andrenelli M.C., Barbetti R., Lo Papa G., Madrau S., Priori S., *Costantini Edoardo A.C.*

CREA, Council for Agricultural Research and Economics; University of Palermo; University of Sassari

INTRODUCTION

A proper management of agricultural lands can aid in mitigating climate change effects on soil properties. However, to be really effective , adaptation measures should be tailored according to specific conditions of climate and soil cover. Soil organic matter and its components are the most sensitive and dynamic properties, which affect many other chemical, physical and hydrological soil properties and qualities. Soil physical and hydrological characteristics, in spite of being mainly indirectly related to climate change, are of particular interest for their paramount importance in shaping soil services . The study of climate change impact on properties of agricultural soils can be pursued with several approaches. The "space-for-time" substitution, in particular, has been applied to the study of soil properties along climo-sequences and to estimate future soil changes at the national and regional scale. The comparison of similar soils, formed by the same set of forming factors, but under different climates, could allow an estimation of the changes that might occur over time.

OBJECTIVES

Our aim was to estimate the climate change impacts on soils under main Mediterranean cropping systems. The impact of climate was decoupled from that of agricultural husbandry through investigating the soil-climate interactions along well defined climosequences of the past (1961-1990), present (1981-2010) and future (2021-2050). Legacy soil profiles were resampled in cereal monocultures on Vertisols of Sicily, permanent pastures and meadows on sandy loam Luvisols of Sardinia, olive tree cultivation in medial Andosols of Campania, and forage and livestock production on loamy Luvisols of Po Plain. Climatic indices were calculated on a 30 km grid and downscaled to 500 m. Future climate was inferred for four stations placed inside the studied areas and related to soil variations.

MAIN RESULTS

The Index of de Martonne (P/T +10; IDM) values in the investigated areas in the first (1961-1990) and second (1980-2010) periods resulted generally lower, pointing to a significant increase in aridity, apart from Sicily, where it remained stable. The linear relationships between IDM and SOC found in the first and second period resulted statistically significant in each studied area, showing no interaction with the period. The relationship between IDM and soil qualities were all significant, except for bulk density and available water capacity, and rather different between the four soil types. Vertisols under cereals and Andosols under olive trees were the most vulnerable, that is, easily affected by small climatic variations, while Luvisols of Po Plain and Sardinia resulted relatively more resilient.

Tab. 1: DM aridity index, main soil qualities, and erosion rate by RUSLE model, in different cropping systems under the past (1961-1990), present (1981-2010) and future (2021-2050) climatic conditions

Cropping system	Decade	IDM	C stock (kg m⁻²)	Soil erodibility (Mg ha h ha⁻¹ MJ⁻¹) (USLE K factor)	Compaction susceptibility (dimensionless)	Crusting susceptibility (dimensionless)	Erosion rate (Mg ha⁻¹ y⁻¹)
Cereal monoculture on Vertisols	1961-1990	20.8	5.76	0.028	1.646	0.637	40.6
	1981-2010	23.1 ↑	6.10 ↑	0.029 ↑	1.744 ↑	0.675 ↑	43.0 ↑
	2021-2050	19.7 ↓	5.41 ↓	0.029 =	1.774 ↑	0.713 ↑	35.9 ↓
Permanent pasture and meadows on sandy loam Luvisols	1961-1990	21.2	4.19	0.046	1.901	1.178	0.1
	1981-2010	19.4 ↓	3.98 ↓	0.044 ↓	1.808 ↓	1.120 ↓	0.1 =
	2021-2050	20.2 ↑	4.10 ↑	0.044 =	1.807 ↓	1.100 ↓	0.2 ↑
Olive cultivation on Andosols	1961-1990	40.0	8.58	0.049	2.014	0.974	20.7
	1981-2010	35.5 ↓	7.25 ↓	0.041 ↓	1.702 ↓	0.823 ↓	17.5 ↓
	2021-2050	33.6 ↓	7.09 ↓	0.041 =	1.707 ↑	0.834 ↑	18.3 ↑
Forage and livestock production on loamy Luvisols	1961-1990	40.9	5.92	0.053	2.053	1.316	29.4
	1981-2010	36.0 ↓	5.15 ↓	0.046 ↓	1.785 ↓	1.144 ↓	25.6 ↓
	2021-2050	41.4 ↑	6.15 ↑	0.045 ↓	1.740 ↓	1.014 ↓	30.4 ↑

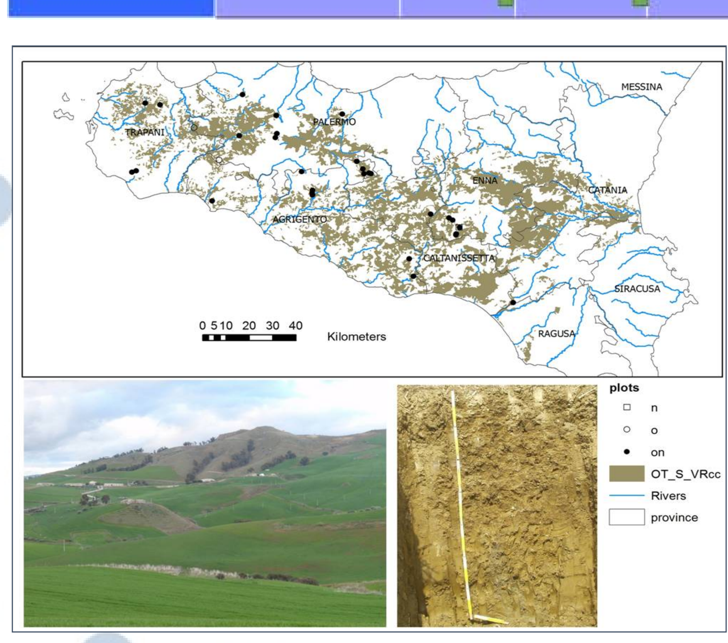


Fig. 1; The extension of the cereal cropping system on CalcicVertisols in Sicily

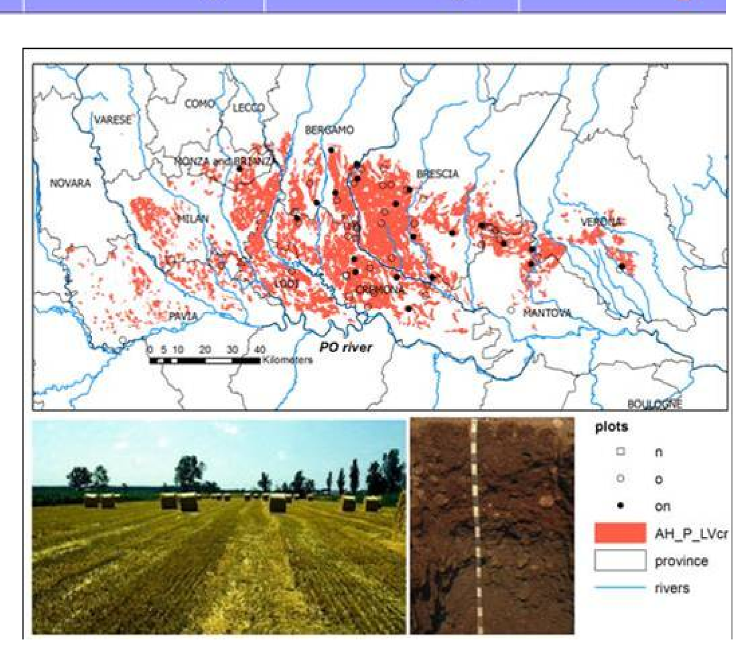
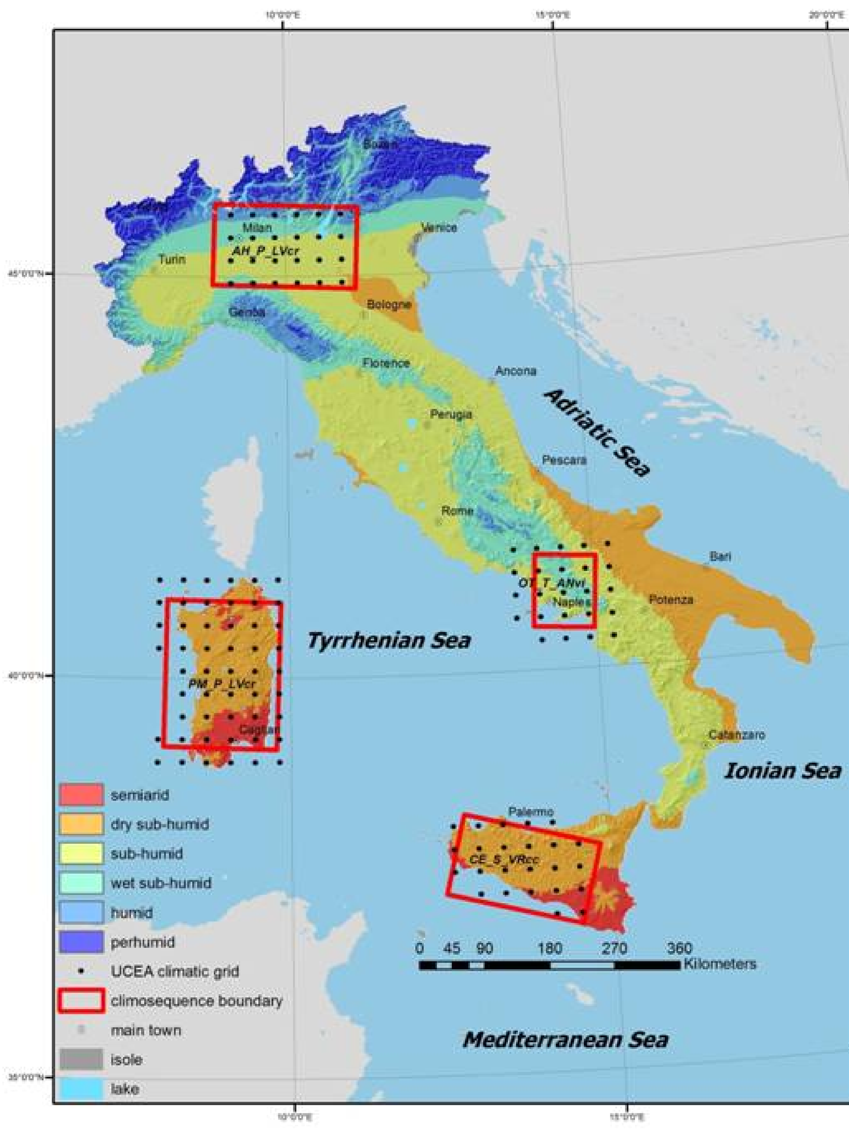


Fig. 2: The extension of the forage and livestock cropping system on Chromic Luvisols in the Po Plain

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria



Map 1: Study areas and climatic regimes

CONCLUSION

The foreseen climate change will produce in the soils during the years 2021-2050 important modifications, not only related to soil organic matter. In fact, changes in erosion rate will on average exceed carbon stock variations. Also crusting susceptibility will vary markedly, in dependence of soil organic carbon. Local variations will be surely greater than the general trend. Therefore the study points to strong interactions between climate change, soil type and cropping system. The results of this study suggest that the implementation of conservative practices, such as conservation agriculture, are particularly to be encouraged for Vertisols under cereal cultivation in dry sub-humid climatic conditions. The study also demonstrates that soil climosequences can be recommended to relate soil quality variations to climatic changes.

GLOBAL SYMPOSIUM ON SOIL ORGANIC CARBON | 21-23 MARCH 2017 | FAO-ROME, ITALY | #GSOC17