APPLICATION OF BIOCHAR AMENDMENTS FOR ENHANCING THE QUALITY OF AGRICULTURAL SOILS CONTAMINATED WITH HEAVY METALS

SUITMA 13 PISA 2025

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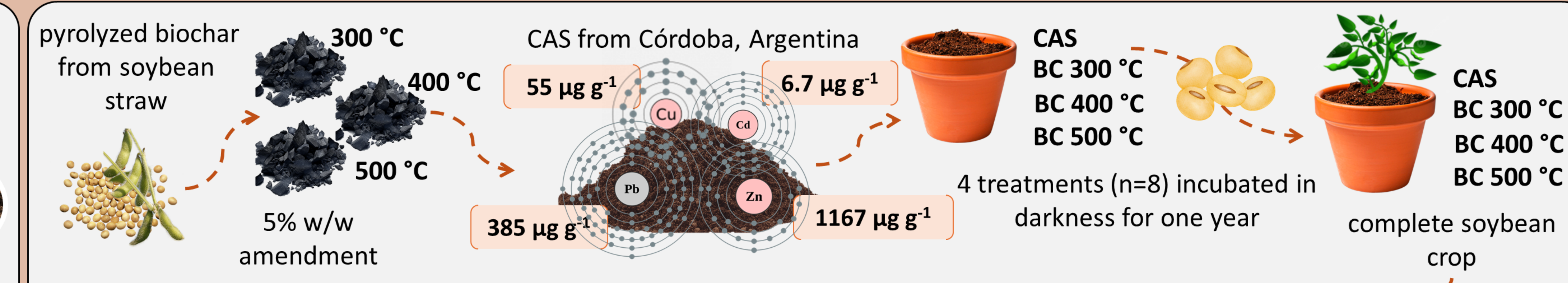
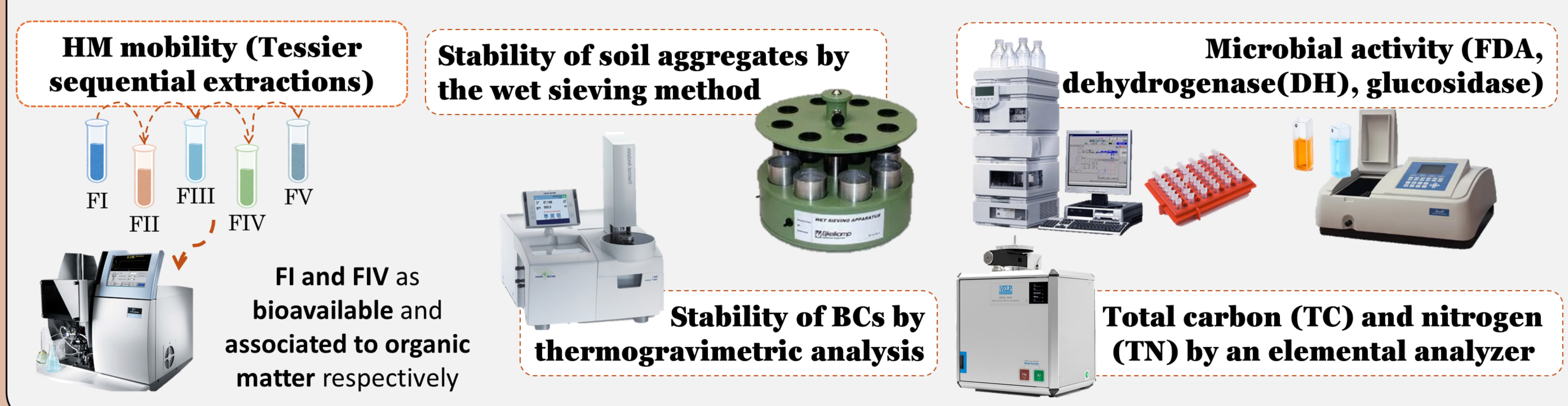
Immobilization of heavy metals (HMs)

Improve soil property and quality

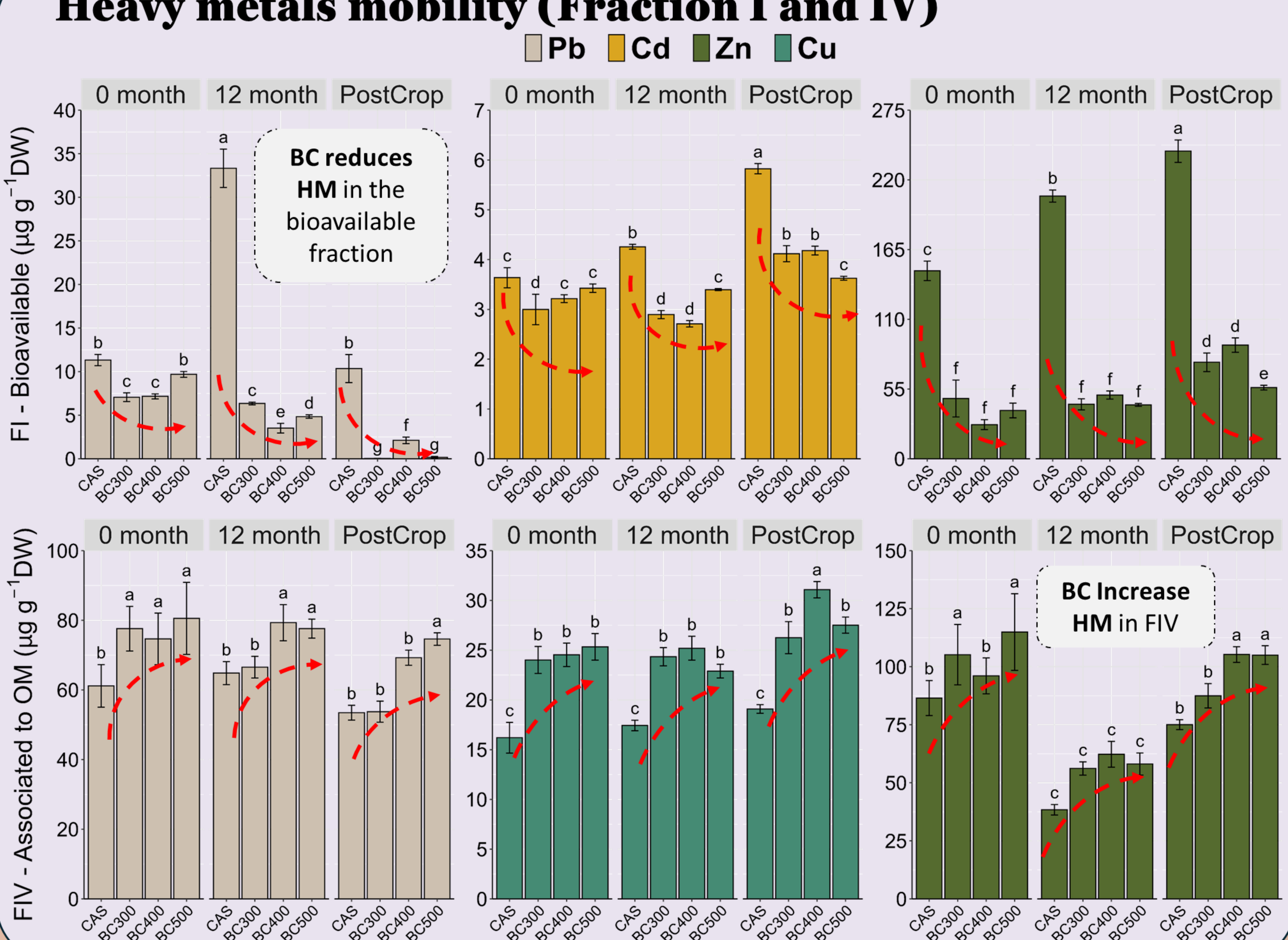
Objective: to determine the effect of BCs from soybean straw produced to different temperatures on the immobilization of HMs in agricultural soils contaminated with Pb, Cd, Cu, and Zn (CAS) and on soil quality.



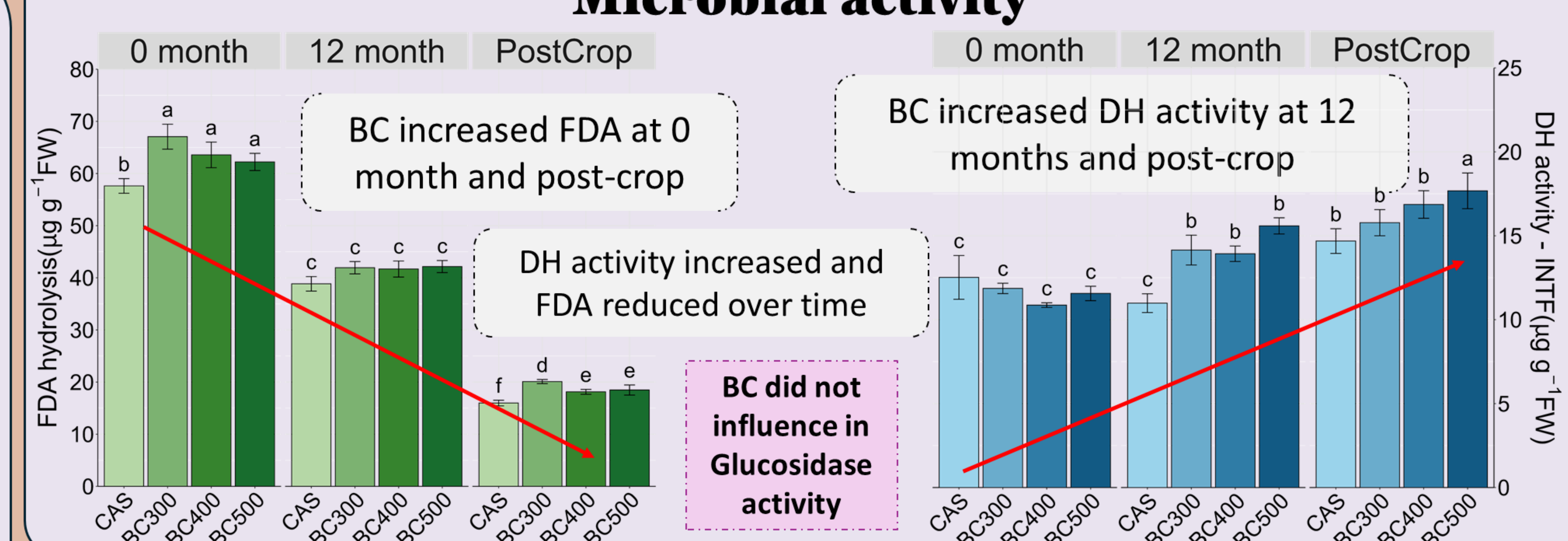
Samples of soils were collected at 0, 12 months and post crop



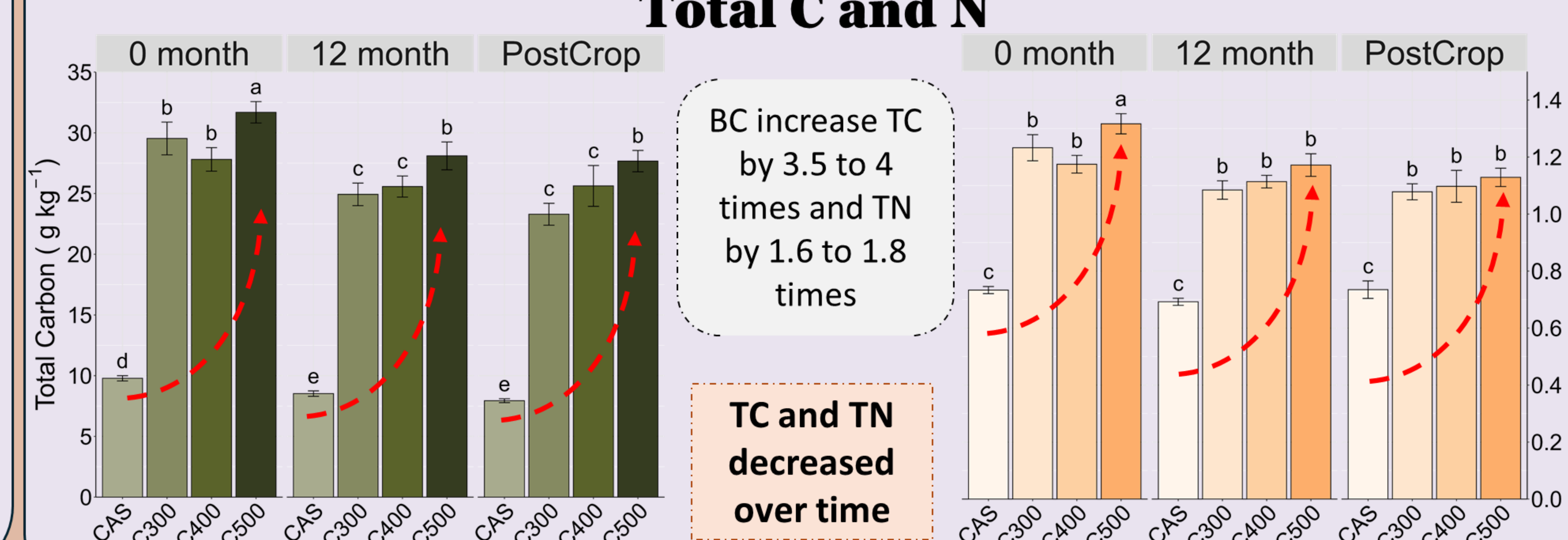
Heavy metals mobility (Fraction I and IV)



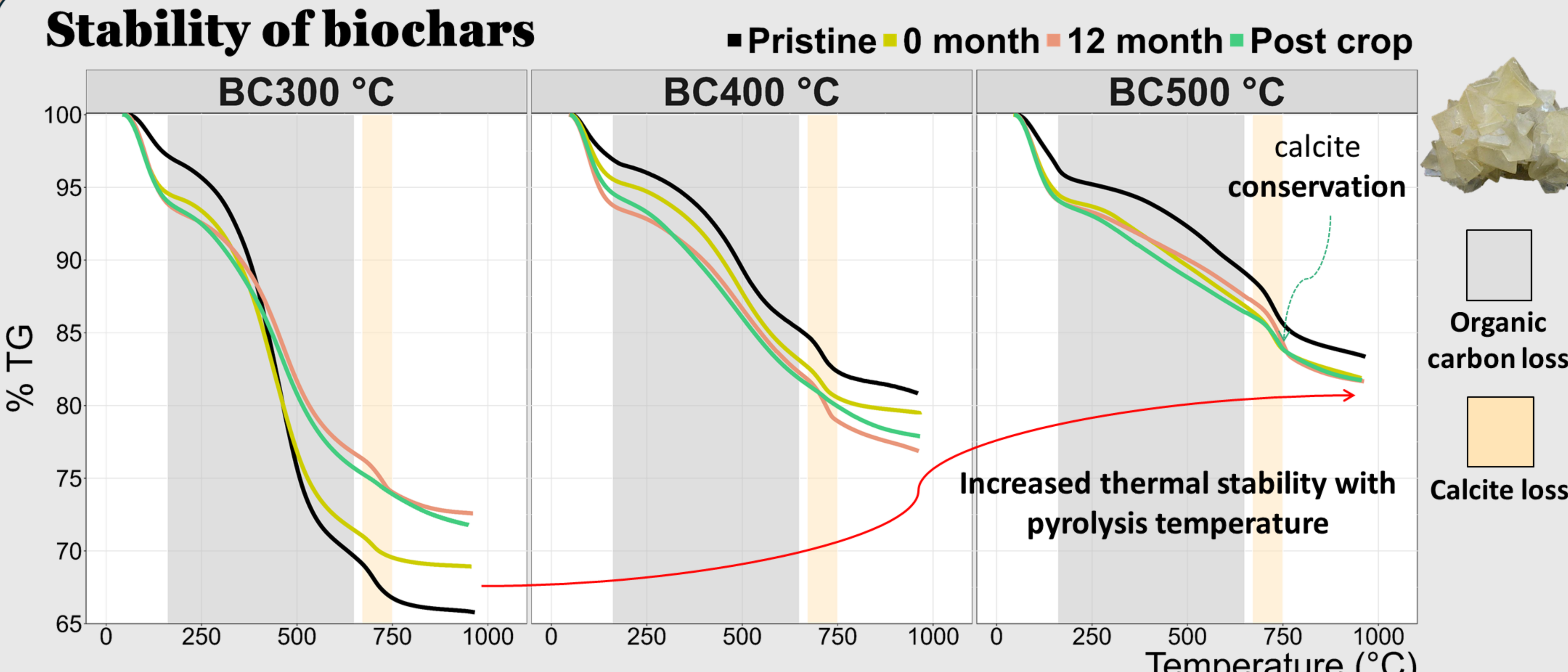
Microbial activity



Total C and N

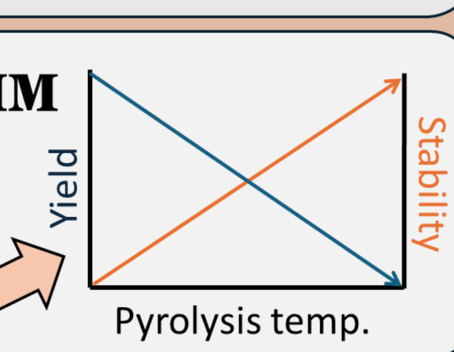


Stability of biochars

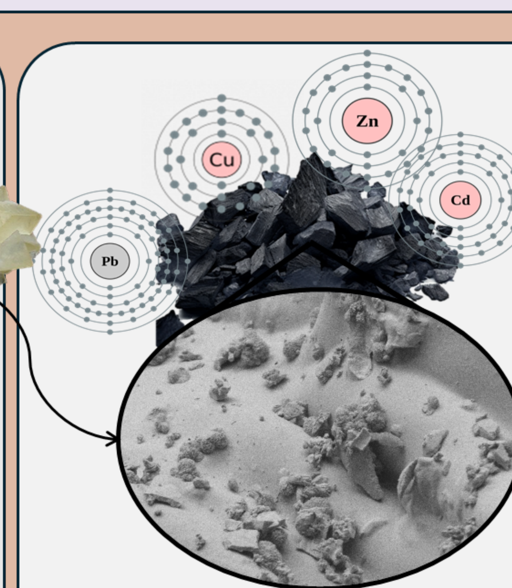


Soybean straw biochar is efficient in immobilizing HM and improving the quality of agricultural soils.

The choice of the BC type should be a balance between yield and its stability in soils

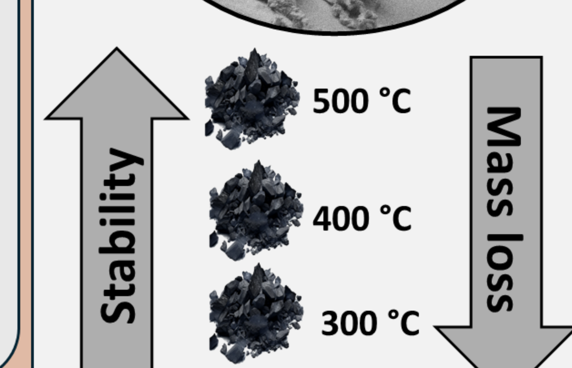


Discussion and conclusions



The increase of HMs in fraction IV shows that **the reduction in fraction I is due to BC.** The immobilization of the HM persisted even after post crop

No significant differences were found in metal immobilization between the different BCs



The TC and TGA results show that **the BC500 °C is the most stable in terms of mass loss and conservation of calcite** (a mineral involved on the immobilization of HM)

Soil aggregate stability improved in all treatments over the time, so **BC did not influence in this parameter**

The enhanced DH activity in BC-treated soils could be by the addition of labile organic matter, coincident with TC results

Acknowledgements:

- **Caracterización y Remediación de la Contaminación de Suelos y Aguas Subterráneas en la era de la Transición Ecológica y Digital CARESOIL-CM (TEC-2024/ECO-69)**
- **Recuperación de suelos urbanos, periurbanos y mineros mediante enmiendas orgánicas y biochar: el secuestro de carbono y la retención de agua como herramientas de mitigación del cambio climático (SEQCHAR). CSIC LINCGLOBAL (ref LINCGL0013)**

CONNECTING ADSORPTION MECHANISMS WITH HEAVY METAL IMMOBILIZATION IN BIOCHAR-AMENDED CONTAMINATED SOILS

SUITMA13 PISA 2025

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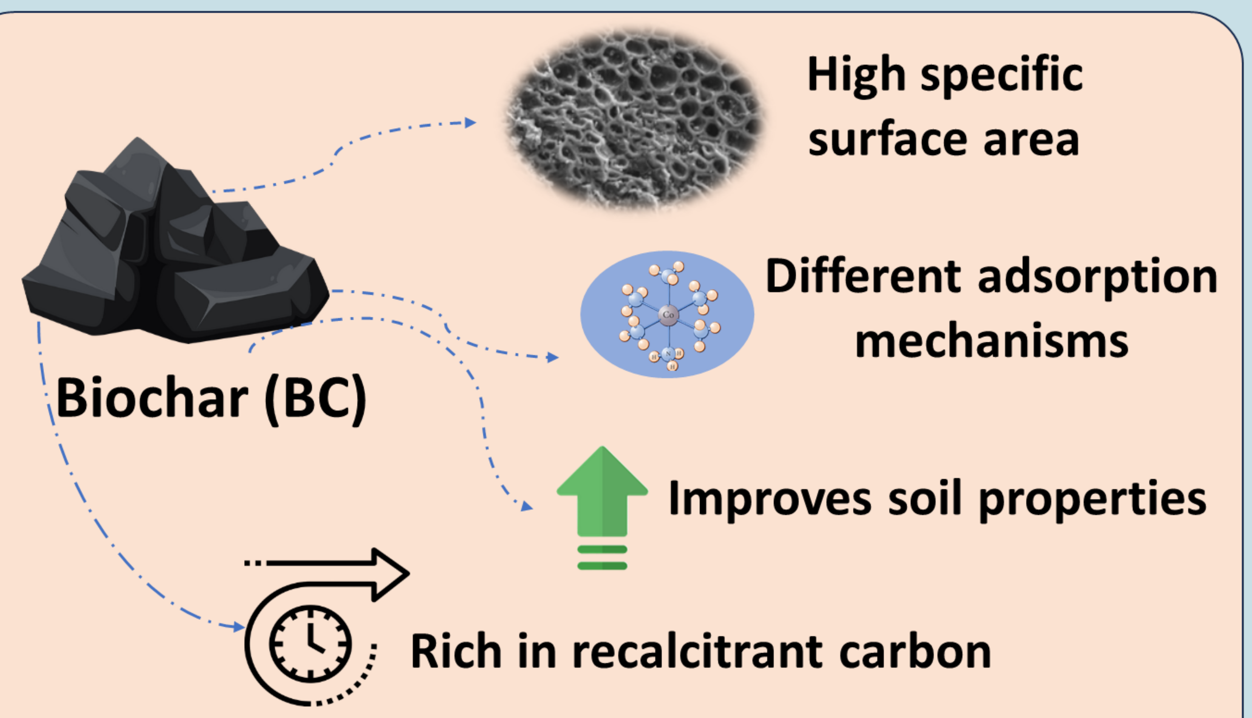
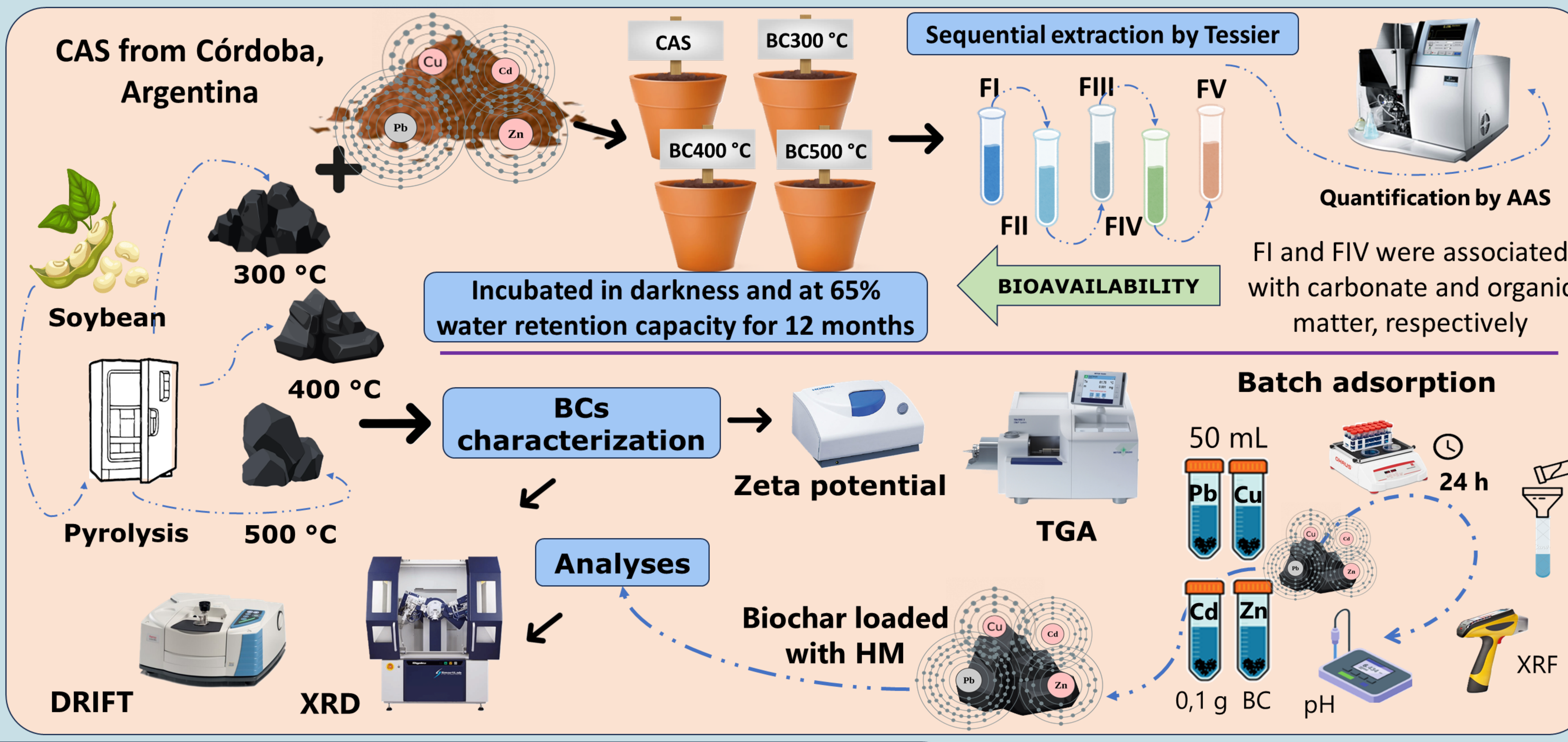
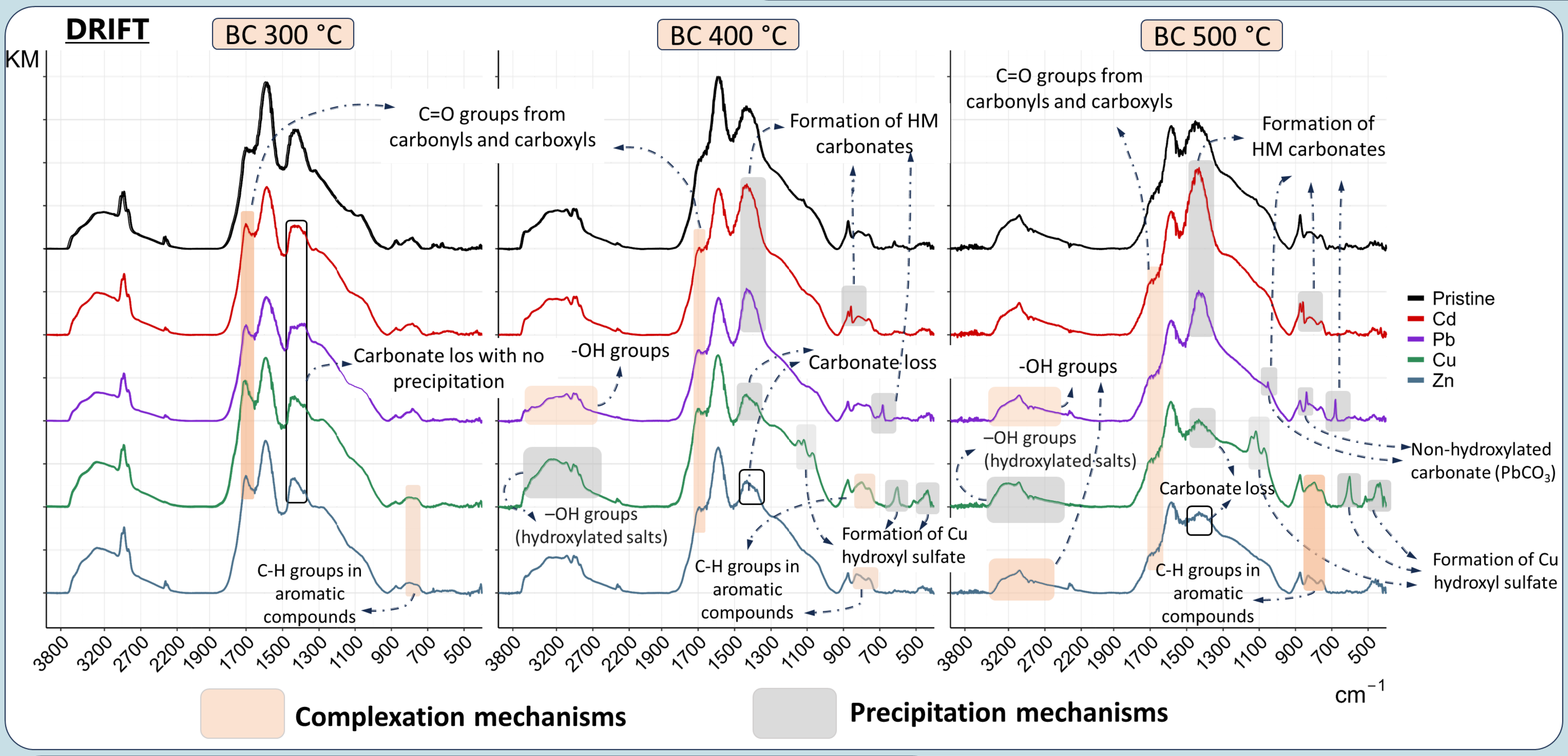
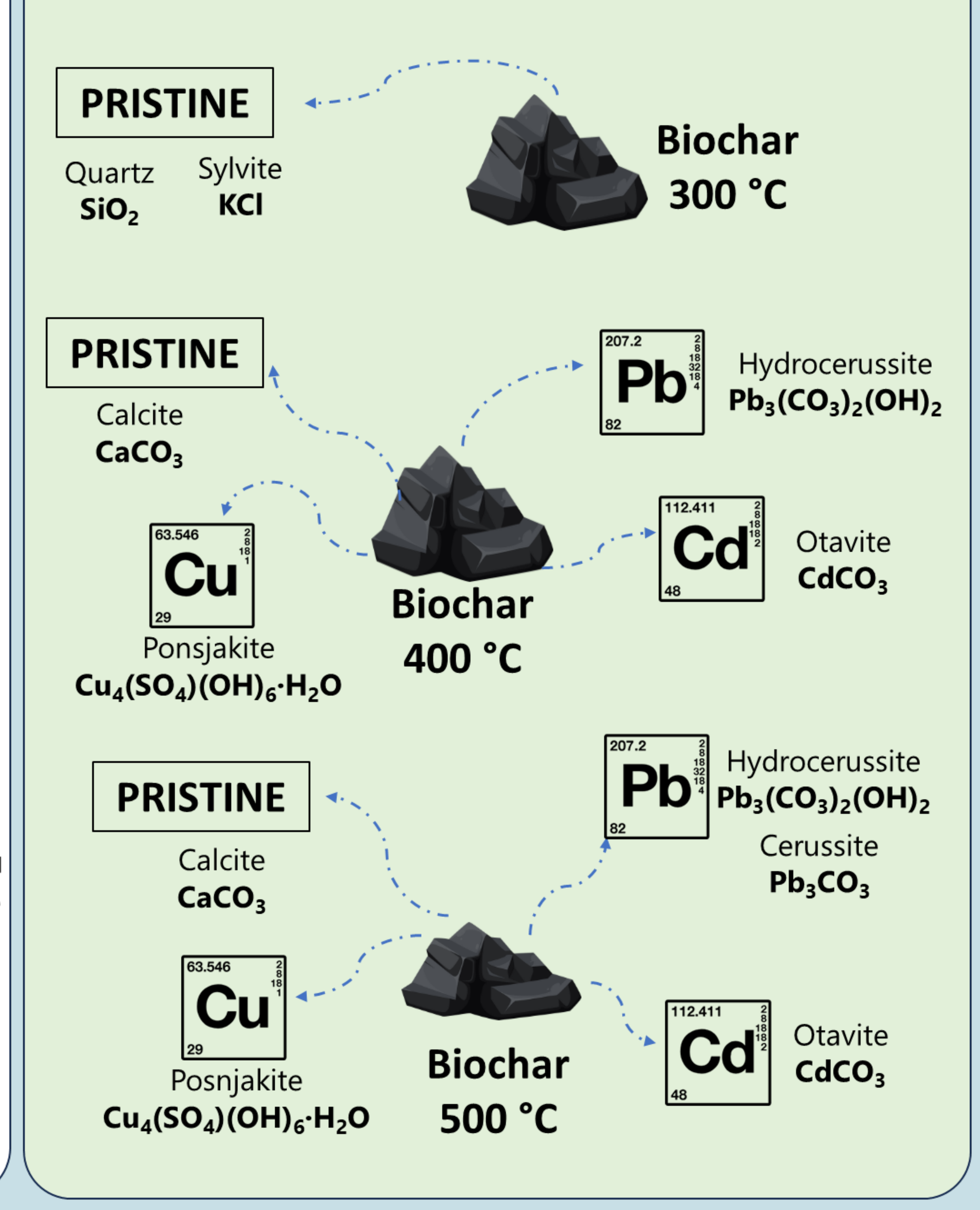


Objective: To study how BC derived from soybean straw influences the distribution of heavy metals (HM) among the chemical fractions of contaminated agricultural soil (CAS), and to correlate the results with the adsorption mechanisms identified in aqueous solutions.

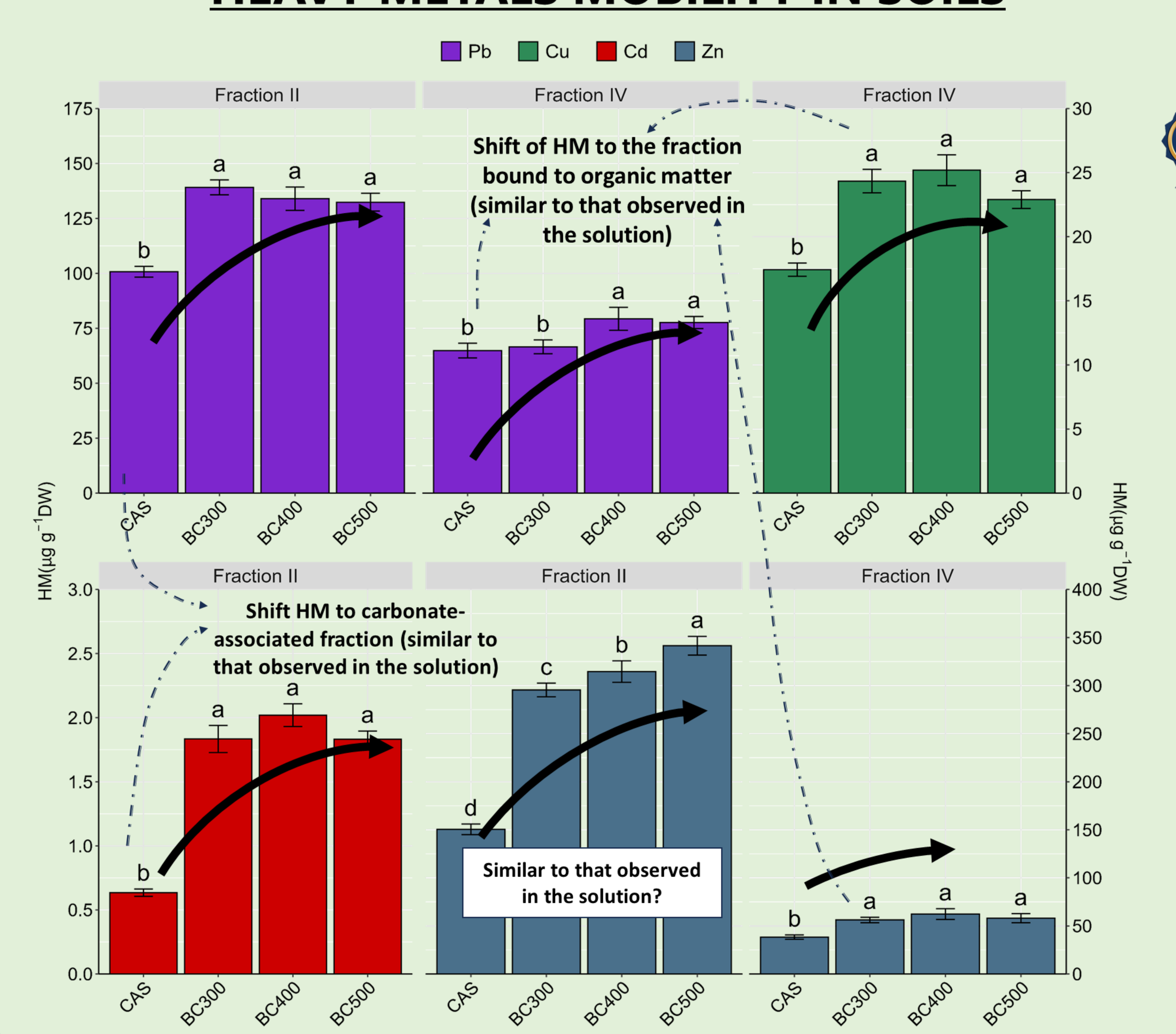




XRD (Precipitate mineral)



HEAVY METALS MOBILITY IN SOILS



T (°C)	C (%)	N (%)	pH	(pζ) pH range (9 – 2)	SSA ($m^2 g^{-1}$)	TGA (%)	$q_{máx}$ ($mg\ g^{-1}$)			
							Pb	Cd	Zn	Cu
300	62	1,9	(9,9 ± 0,5)	(-47 to -17)	0,93	34	(201 ± 3) B	(50 ± 2) B	(49 ± 4) A	$(8 \pm 2).10^1$
400	65	2,0	(10,7 ± 0,3)	(-49 to -25)	3,38	19	(275 ± 8) A	(59 ± 3) A	(48 ± 3) A	(87 ± 7)
500	64	1,8	(10,7 ± 0,3)	(-40 to -16)	10,21	17	(150 ± 7) C	(46 ± 2) B	(39,5 ± 0,3) B	(75 ± 8)

1st

DISCUSSION AND CONCLUSIONS

↑ BC showed increased specific surface area, thermal stability, C and N contents, and pH with higher pyrolysis temperatures.
The BC produced at 400 °C exhibited the highest adsorption capacity for all HM.
Calcite and silicate became more evident at higher temperatures.

Post-adsorption analyses revealed the **complexation** of all HMs with C=O groups (decreasing with temperature), the **complexation** of Zn with aromatic C–H groups (increasing with temperature), and the calcite-mediated **precipitation** of Cd, Cu, and Pb in BC400 and BC500

BC amendment shifted Cu to the organic matter–bound fraction, and Pb, Cd, and Zn to both the carbonate-associated and the organic matter–bound fractions. Temperature-enhanced immobilization was observed only for Cd and Zn.

The distribution of HMs in the amended soils reflected the adsorption mechanisms observed in the solution experiments, with the exception of Zn. The effect of BC pyrolysis temperature influenced HM adsorption in solutions but not in the amended soils.

Acknowledgements:
- Caracterización y Remediación de la Contaminación de Suelos y Aguas Subterráneas en la era de la Transición Ecológica y Digital CARESOIL-CM (TEC-2024/ECO-69)
- Recuperación de suelos urbanos, periurbanos y mineros mediante enmiendas orgánicas y biochar: el secuestro de carbono y la retención de agua como herramientas de mitigación del cambio climático (SEQCHAR). CSIC LINCGLOBAL (ref LINCGL0013)

Comunidad de Madrid

Quantification And Monitoring of Trace Elements and Nutrients in Rooftop Crops in Madrid: Implications for Food Safety

UAM
Comunidad de Madrid
CSIC Consejo Superior de Investigaciones Científicas
ICA Instituto de Ciencias Agrarias

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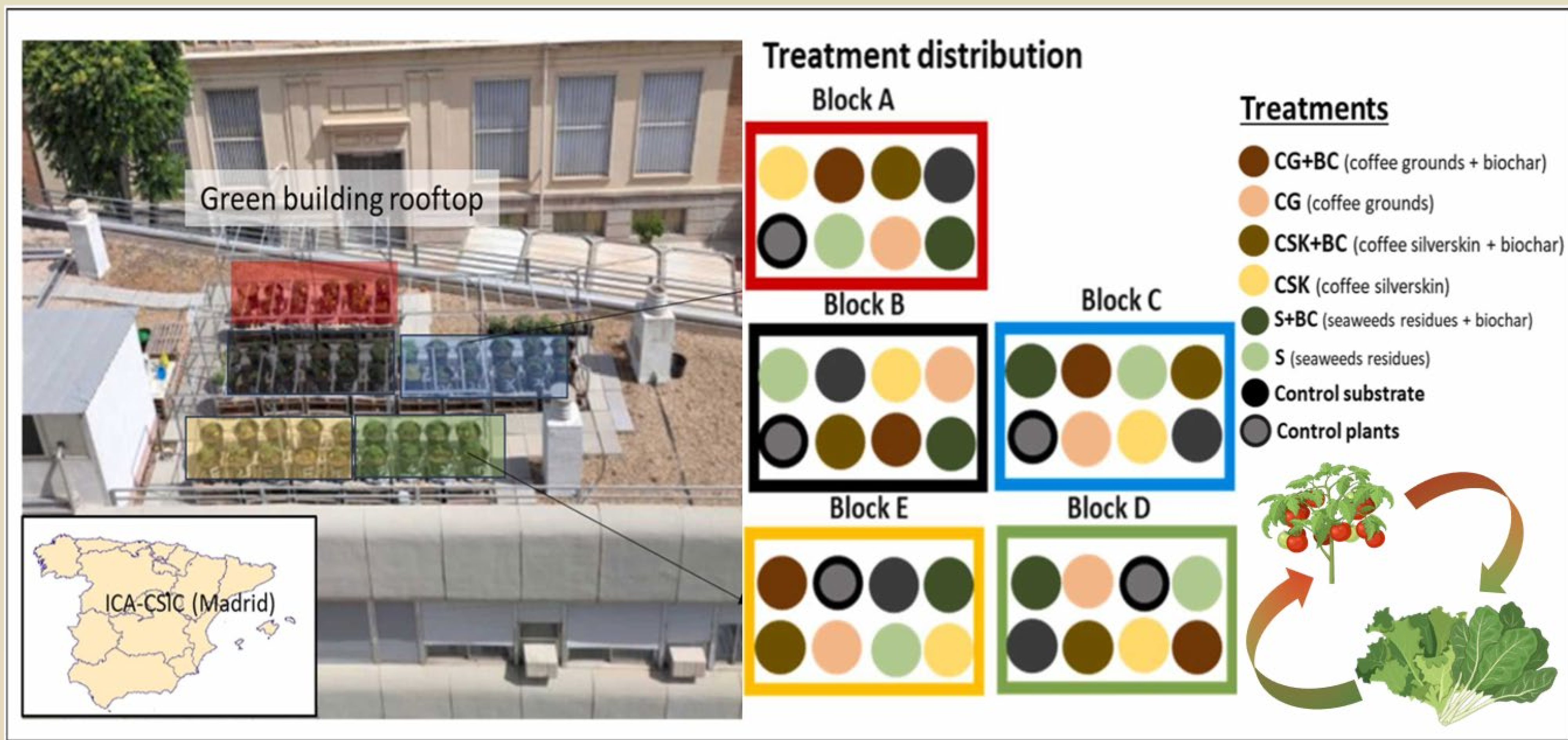
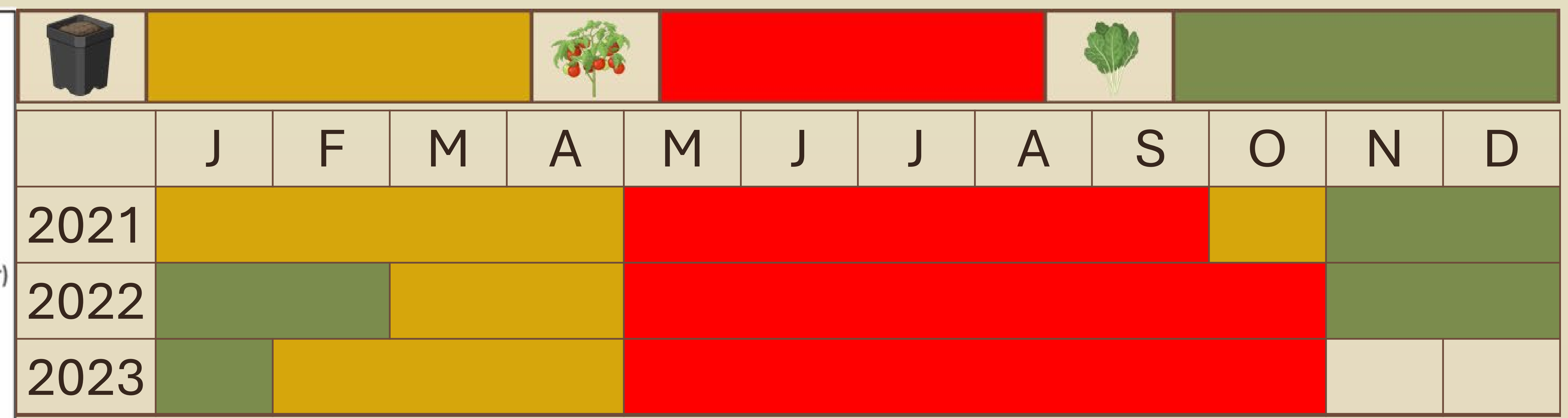
Background

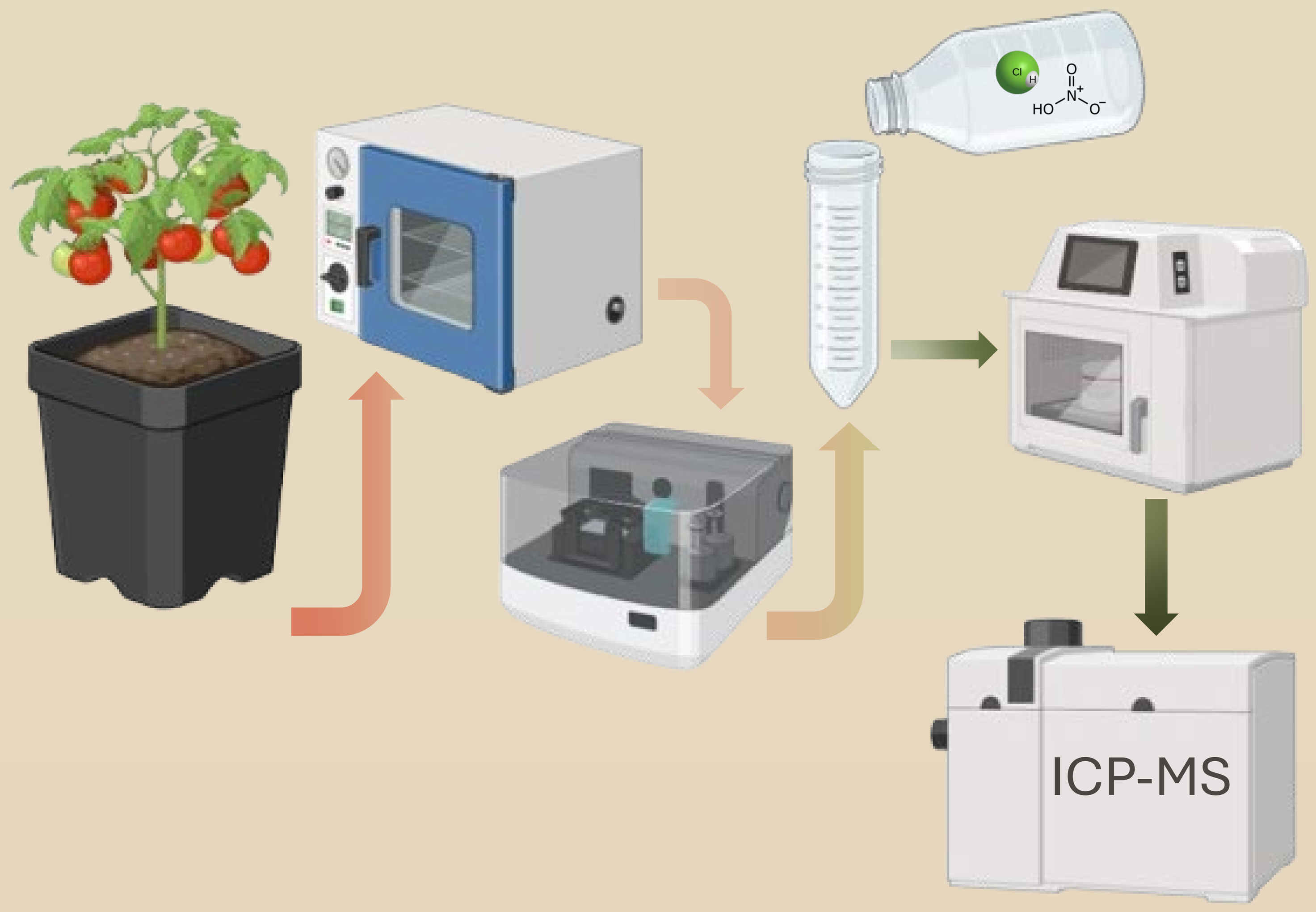
In urban rooftop agriculture the use of compost poses **risks of trace elements accumulation in crops**.
Due to its high porosity and retention capacity, **Biochar** could stabilize substrates, reduce contaminant mobility and improve nutritional efficiency. This study evaluates the its **effects on substrate composition, element translocation to crops and leaching in a productive rooftop system.**





Analysis

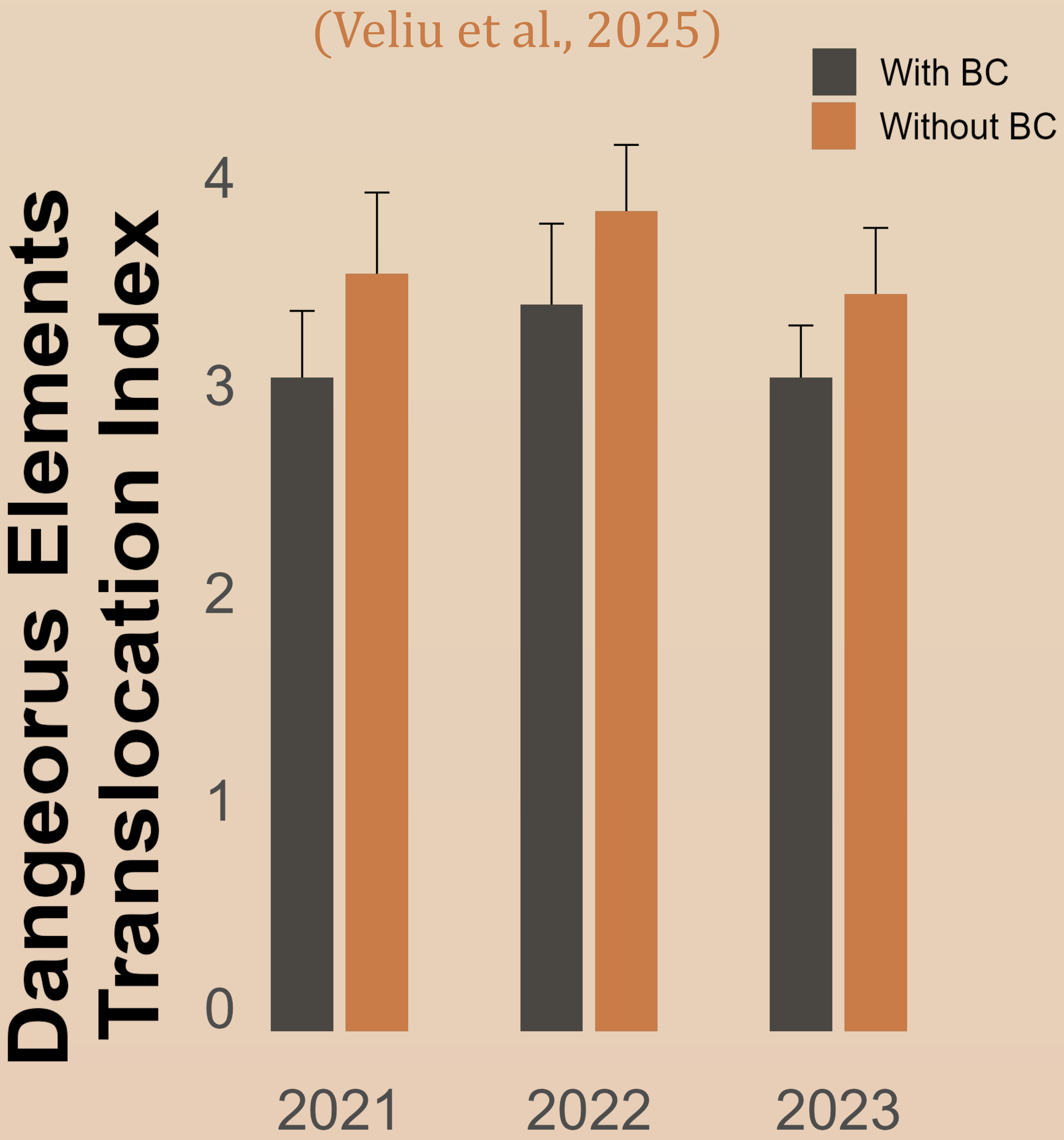
- **Analysis**: pH, EC, C, N, macro- and micronutrients, **trace elements in substrates, aerial biomass and leachates**
- **Instrumentation**: ICP-MS and statistics with R/SPSS.



Results and Conclusions

$$TIndex = \frac{Cfruit, i}{Csubstrate, i, t0}$$

(Veliu et al., 2025)

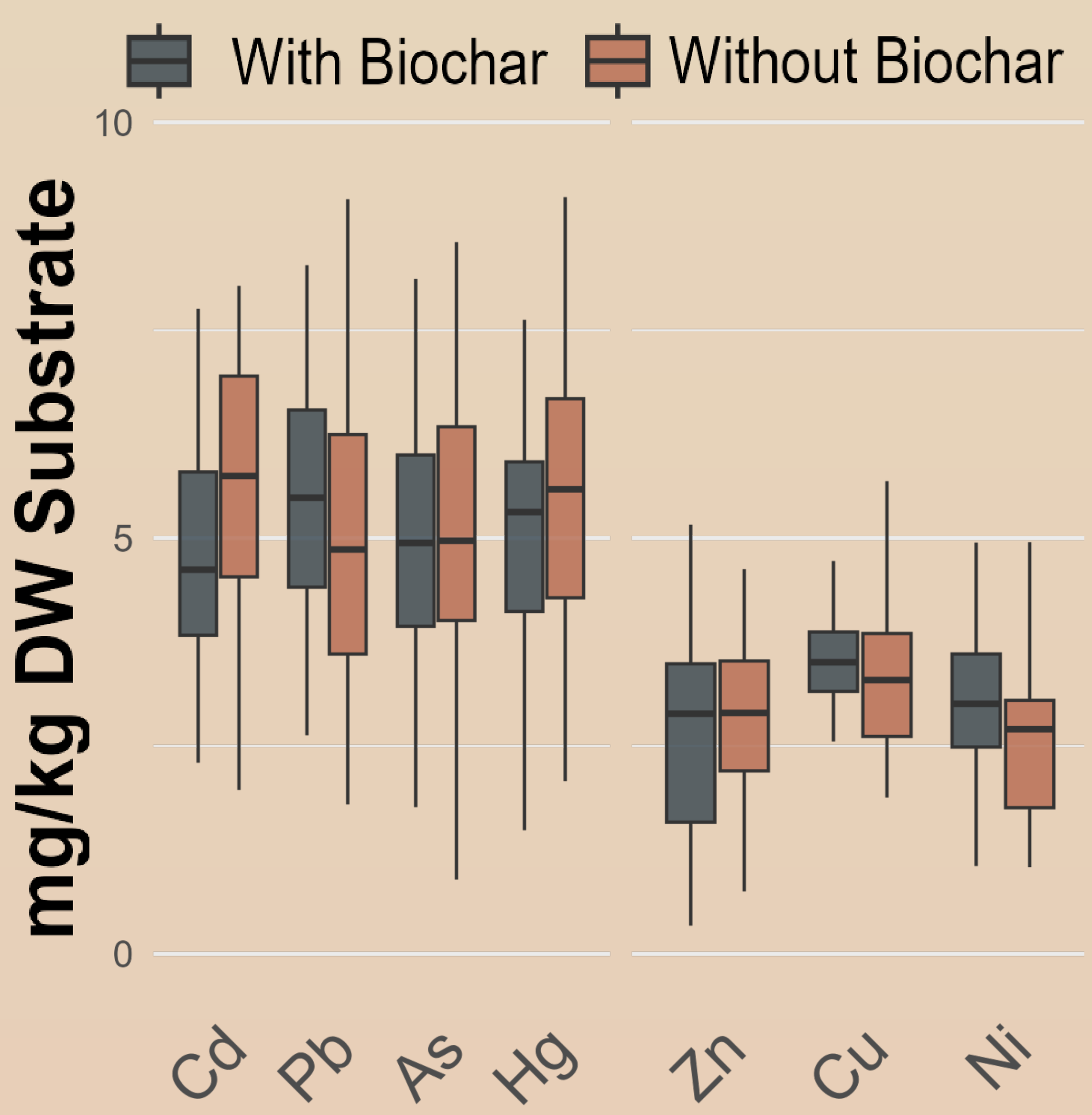


Biochar consistently reduced the total concentration of potentially dangerous elements, while enhancing nutrient stability.

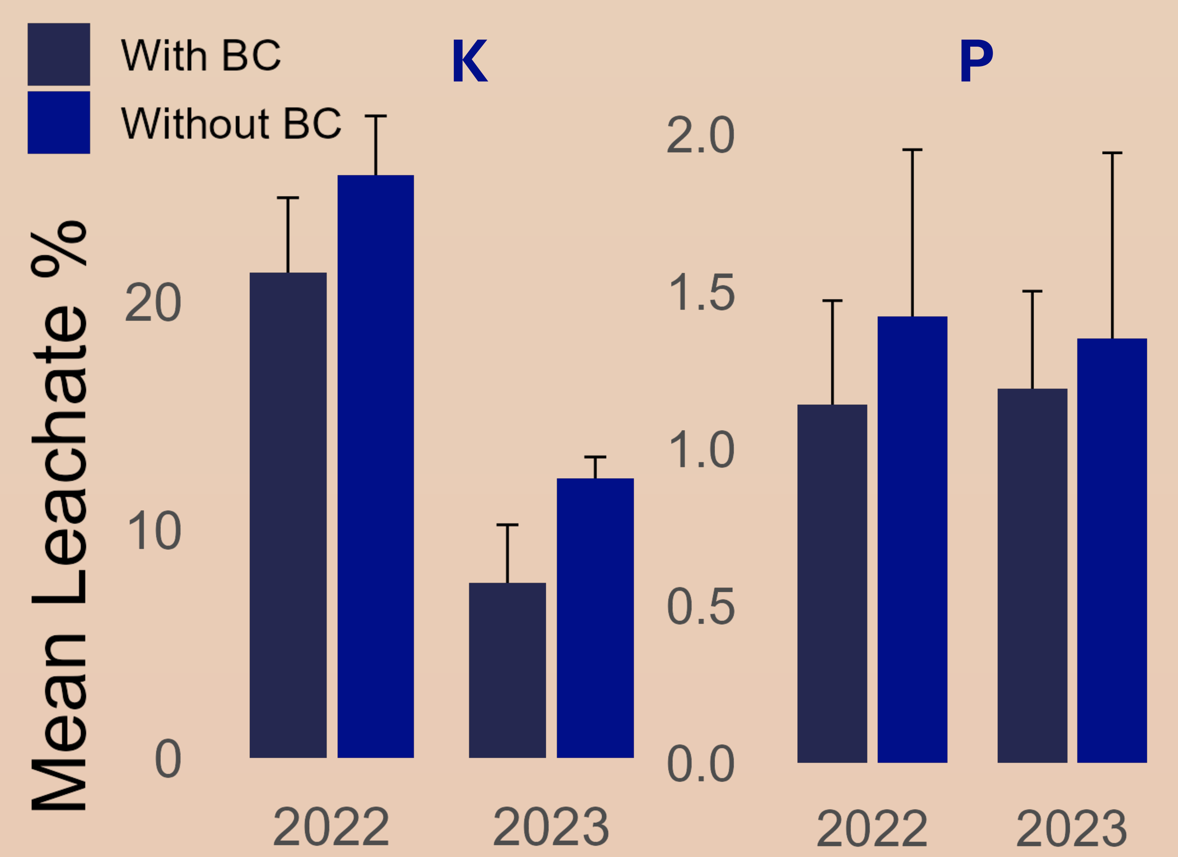
Biochar **stabilized pH and reduced electrical conductivity**, especially in substrates with coffee.

Biochar reduced Dangerous Elements uptake, keeping fruit levels within legal limits.

27 % less K and 40 % less P in leachate observed in substrates with biochar, showcasing higher nutrient retention.



$$\% \, Element \, Leached = \left(\frac{Average \, leached \, element}{Total \, leaching}\right) x \, 100$$



Bibliography

Veliu, M., López-Romano, H., Picca, G., Panettieri, M., Moreno-Jiménez, E., Courtier-Murias, D., Jean-Soro, L., Gasperi, J. & De Sosa, L.L. (2025). Biochar–Compost blends modulate trace element and nutrient dynamics in rooftop farming systems under Mediterranean conditions. Ecotoxicology and Environmental Safety, 302: 118663. doi: 10.1016/j.ecoenv.2025.118663.

Sánchez-Monedero, M.A., S ánchez-García, M., Castej ón-del Pino, R., Fornes, F., Belda, R.M., Lid ón, A., Cayuela, M.L., 2021. Biochar as an additive in composting: impact onprocess performance and on the agronomical quality of the end product. Acta Hortic.175–188. https://doi.org/10.17660/ActaHortic.2021.1317.21.

Acknowledgements

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Road Infrastructures and the direct and induced Impacts on Soil Sealing. An Analysis on the Highway A35, in Italy.

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[1]Department of Architecture and Urban Studies, Milan, Italy

1. The context

Seal sealing was identified as one of the main soil degradation processes in the EU's soil thematic strategy. Studying the contemporary soil sealing processes is urgent to tackle with the challenges for the future sustainable management of soil & land in relation to urban planning strategies.

The contribution investigates the **impacts on land-use changes** and on the **increase of soil sealing** derived from the construction of a new road infrastructure, such as highways. Such infrastructures are relevant cases since they **can impact** both **directly** and **indirectly** on the **land cover**: directly if we consider the soil sealing produced by the **infrastructure itself** (the natural soil taken to realize the highway); indirectly if we consider the inducted transformations enhanced by the realization of the highway (e.g. other **new infrastructures** connected to the highway or **productive** and **logistic areas** close to it).

This analysis can be regarded as part of a broader reflection on the **environmental impacts of road infrastructures**, which can affect not only the territory directly involved in the realization of the road, but also a broader buffer zone, the so-called **road-effect zone** (i.e. the buffer area in which it is possible to detect environmental impacts caused by the infrastructure).

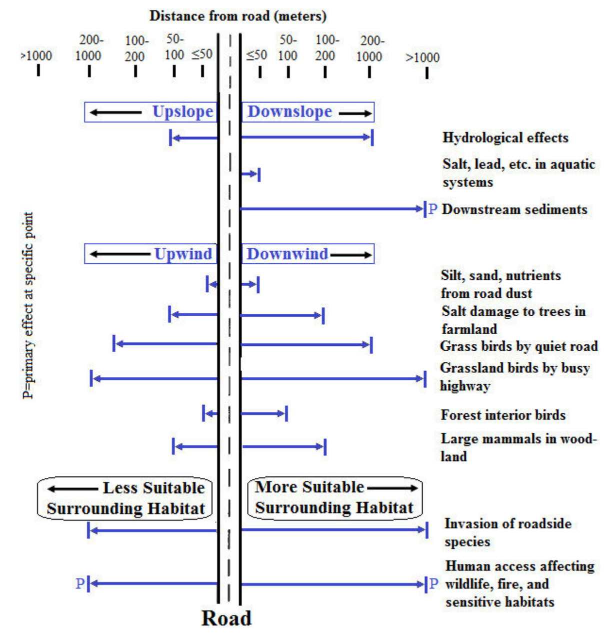


Fig. 1 - Road-effect zone defined by ecological effects.
Source: Kollarou et al. 2013.

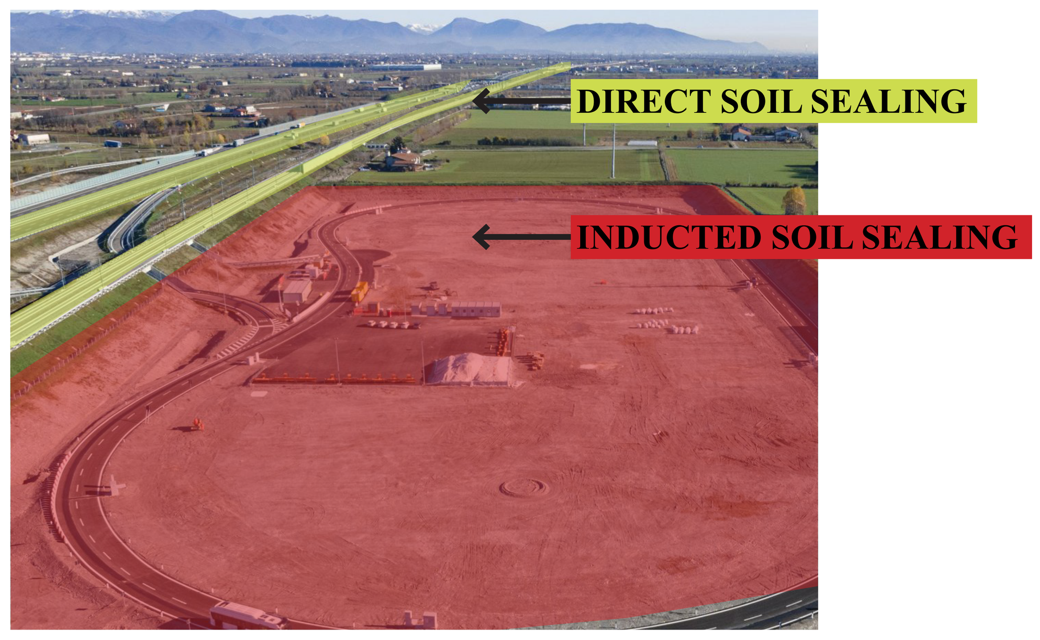


Fig. 2 - Example of road-effect zone defined by impacts on soil sealing.
Source: Elaboration by authors

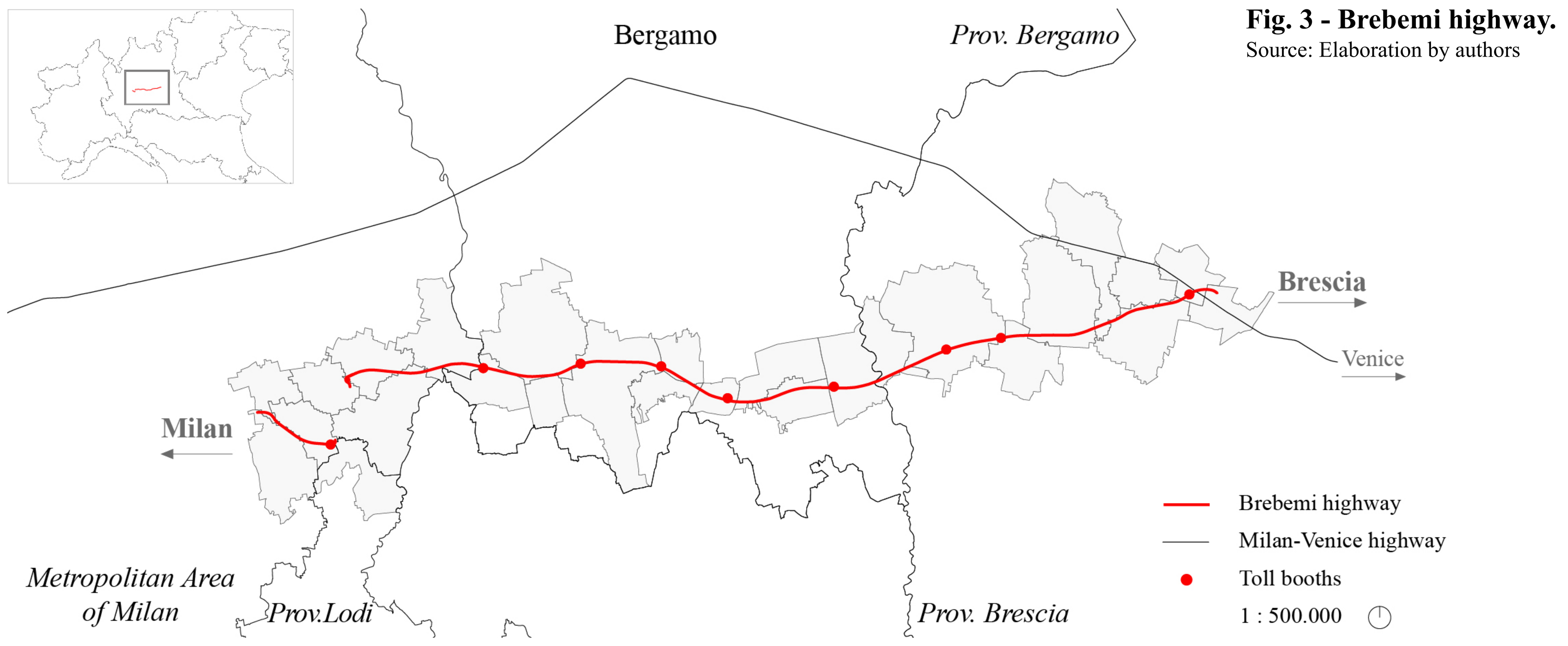
2. The case study: Brebemi highway

It is still little investigated how quantifying the road-effect zone in the case of the impacts on land transformations and soil consumption. To expressly measure this influence, the study focuses on the case of the **highway A35**, also known as **Brebemi** (since it connects the cities of Brescia and Milan, by passing thought the Bergamo Province), recently realized in the Lombardy Region (Italy) (**Fig. 3**). It represents one of the **first scientific quantification** of direct and inducted land transformations related to this new mobility infrastructure.

The Brebemi highway was selected as case study for the following reasons:

- Lombardy is a **hotspot** for studying **soil sealing** phenomena, as it is one of the Italian regions with the highest rate of soil consumption and sealing;
- the highway is located in a **plain and rural context** with a **high natural value**. The Brebemi crosses four regional parks. In addition, a huge portion of the territory crossed is classified by the Lombardy Region as Priority areas for the biodiversity;
- its importance of the Brebemi in the **public debate** (local, regional and national). It has been strongly criticized since there was already a highway connecting Brescia and Milan (the Milan-Venice highway) that it is still the most used due to the less expensive toll.

Fig. 3 - Brebemi highway.
Source: Elaboration by authors



3. The methodology

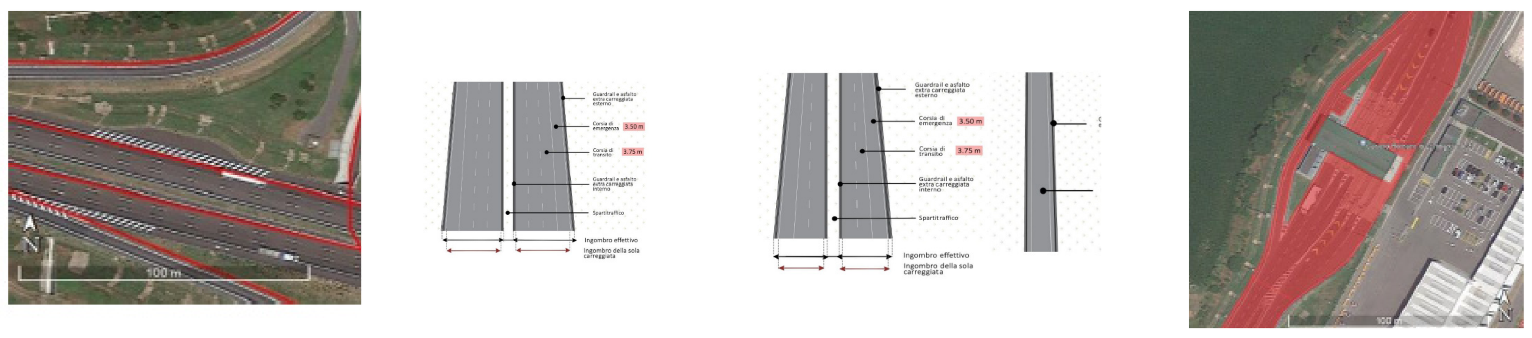
There are two main methodological steps.

3.1. Definition of the areas of study made by:

a. The area of the **Brebemi highway** (meant as "footprint" to the ground) related to the study of the **direct soil consumption** (**Dsc**) (**Fig. 4**);

b. The area of the **infrastructures** (meant as "footprint" to the ground) connected or related to the Brebemi highway, related to the study of the **linear inducted soil consumption** (**linear Isc**) (**Fig 5**);

c. The area close to the Brebemi highway, namely a **buffer zone of 500m** from each side of the road, related to the **areal inducted soil consumption** (**areal Isc**).



Step 1: linear track of OpenStreetMap

Step 2: Calculation of the width of the highway, depending on 3 different types

Step 3: Calculation of the complementary elements (emergency lane, the service areas or the toll booths)

Fig. 4 - Methodological steps to define the area of the Brebemi highway. Source: Elaboration by authors

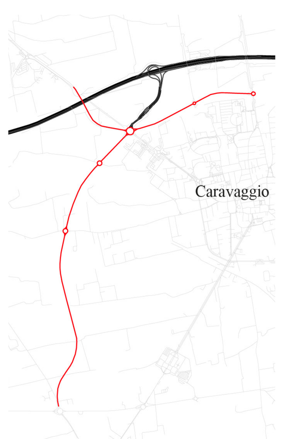
3.2. Calculation of land cover changes due to the highway and inducted infrastructures and new urbanised areas.

All the calculations on land cover were carried out with Gis analysis and thanks to the regional database DUSAF. Such database is organized with the same legend and classification of the European Corinne Land Cover.

On the basis of this classification, the analysis considers:

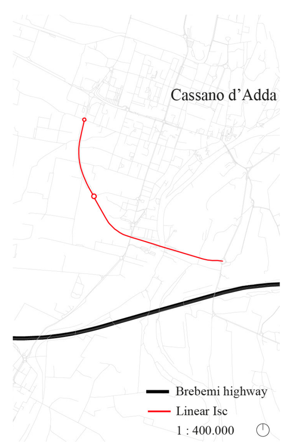
- as **urbanised areas** all those areas whose land cover belongs to class 1, except the class 1.4 (namely urbanized areas are made on the sum of the classes 1.1,1.2 and 1.3);
- as **soil consumption**, the transformation of natural areas (namely all those areas whose land cover belongs to the classes 1.4, 2 and 3) into urbanized areas.

Since the construction of Brebemi started in 2009 and ended in 2014, while the project had begun to be discussed before the 2000s, we have taken three DUSAF version: 1999, 2007 and 2018.



Type 1: new roads realized to link the Brebemi highway with the territory

Type 2: modification of existed roads, interrupted or deviated by the Brebemi



Type 3: new roads realised as Brebemi compensatory interventions

Fig. 5 - Three inducted infrastructure's types. Source: Elaboration by authors

4. The results

289 ha
Footprint of Brebemi highway

↓

278 ha
Direct soil consumption (Dsc)

145 ha
Footprint of infrastructures related to Brebemi highway

↓

117 ha
Linear inducted soil consumption (linear Isc)
Period 1999-2018

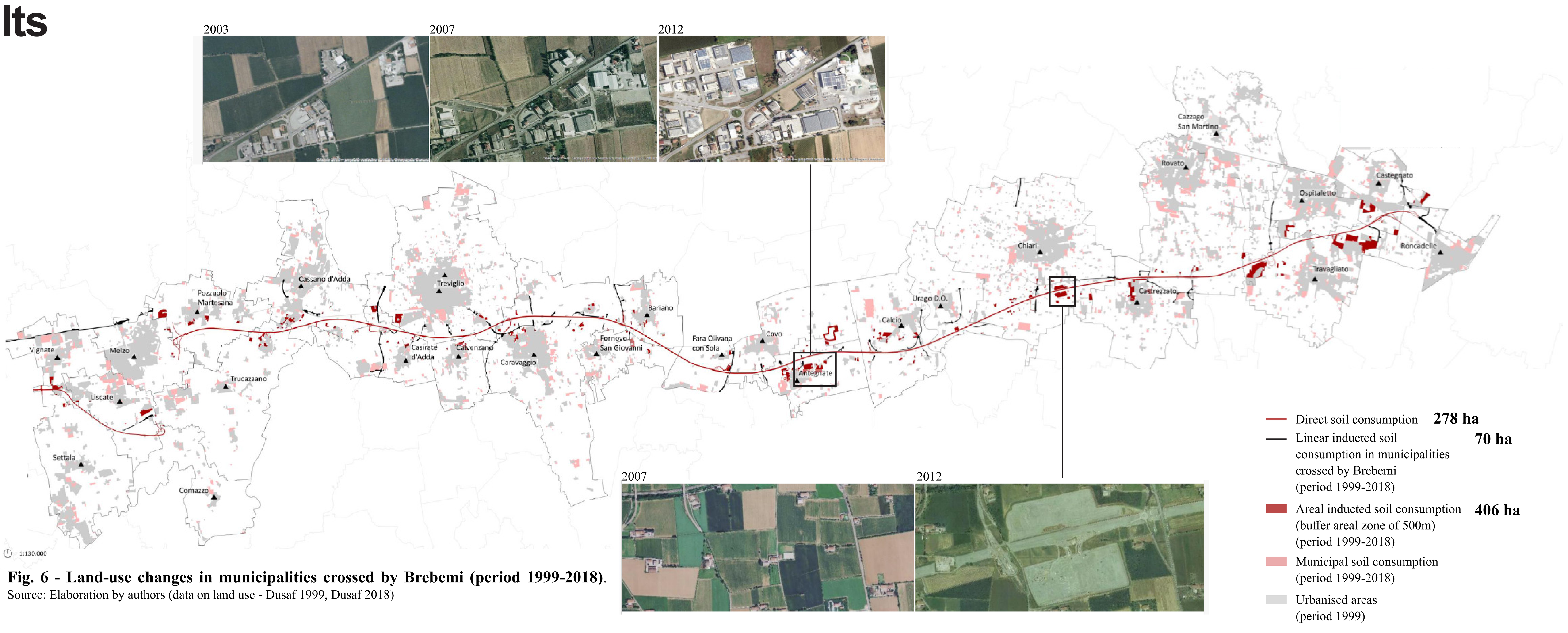


Fig. 6 - Land-use changes in municipalities crossed by Brebemi (period 1999-2018).
Source: Elaboration by authors (data on land use - Dusaf 1999, Dusaf 2018)