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Influence of organic amendments from date palm residues : impacts on soil water retention and carbon mineralisation in arid and semi-arid regions soils

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Introduction

Cultivated soils from dryland areas generally presents low fertility due to pedoclimatic context. Soil organic matter (SOM) management with the recovery of organic wastes is proposed as a mean of improving soil fertility. As part of the ISFERALDA project (Improving Soil FERTility in Arid and semi-arid regions using Local DATE palm residues), the effects of date palm residues converted to compost and biochar on some soil properties were studied.

Objectives

- Quantifying the effects of compost and/or biochar on soil water retention
- Studying the dynamics of carbon mineralisation under controlled conditions

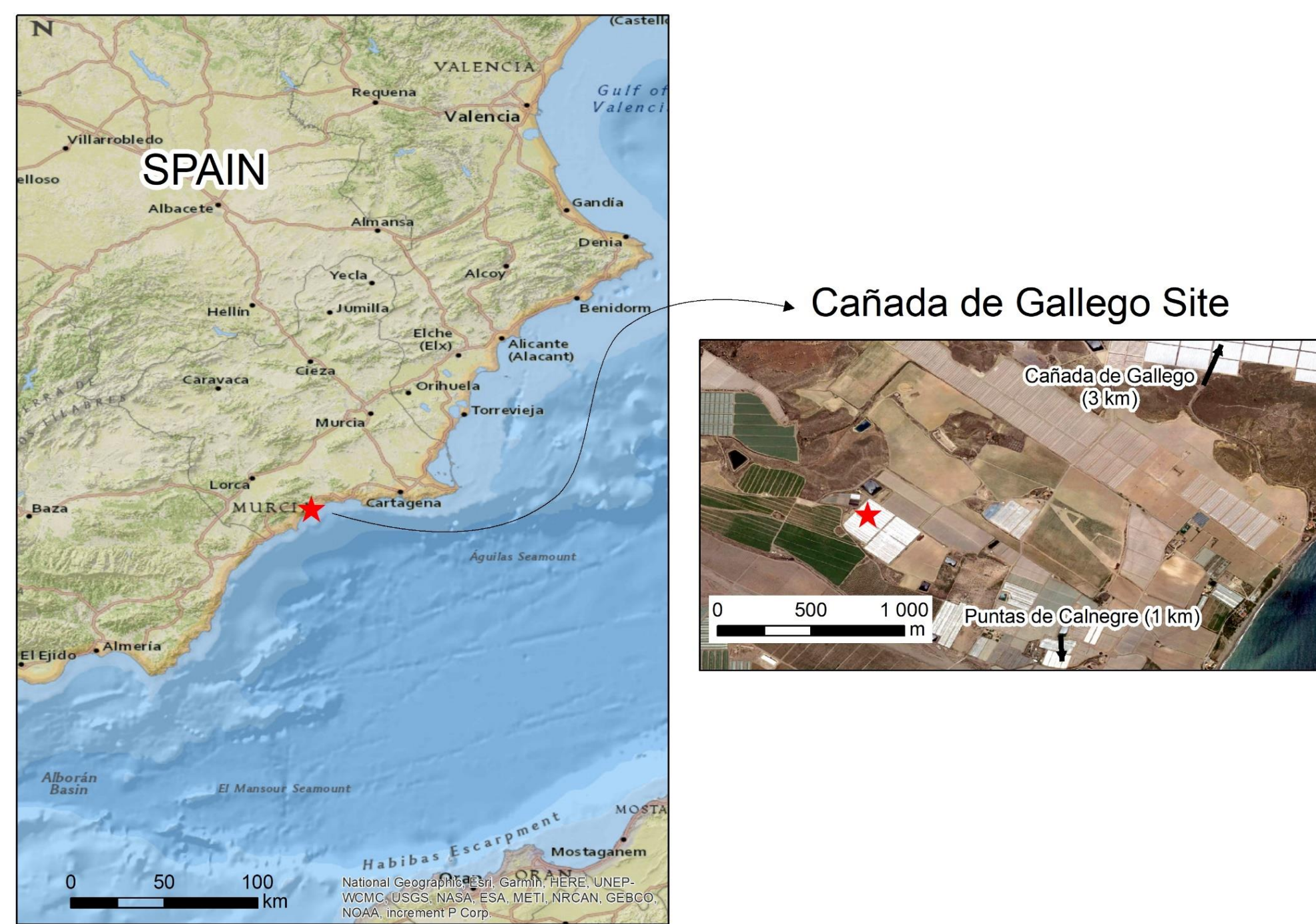
Methodology for soil water retention

Location : south-east Spain

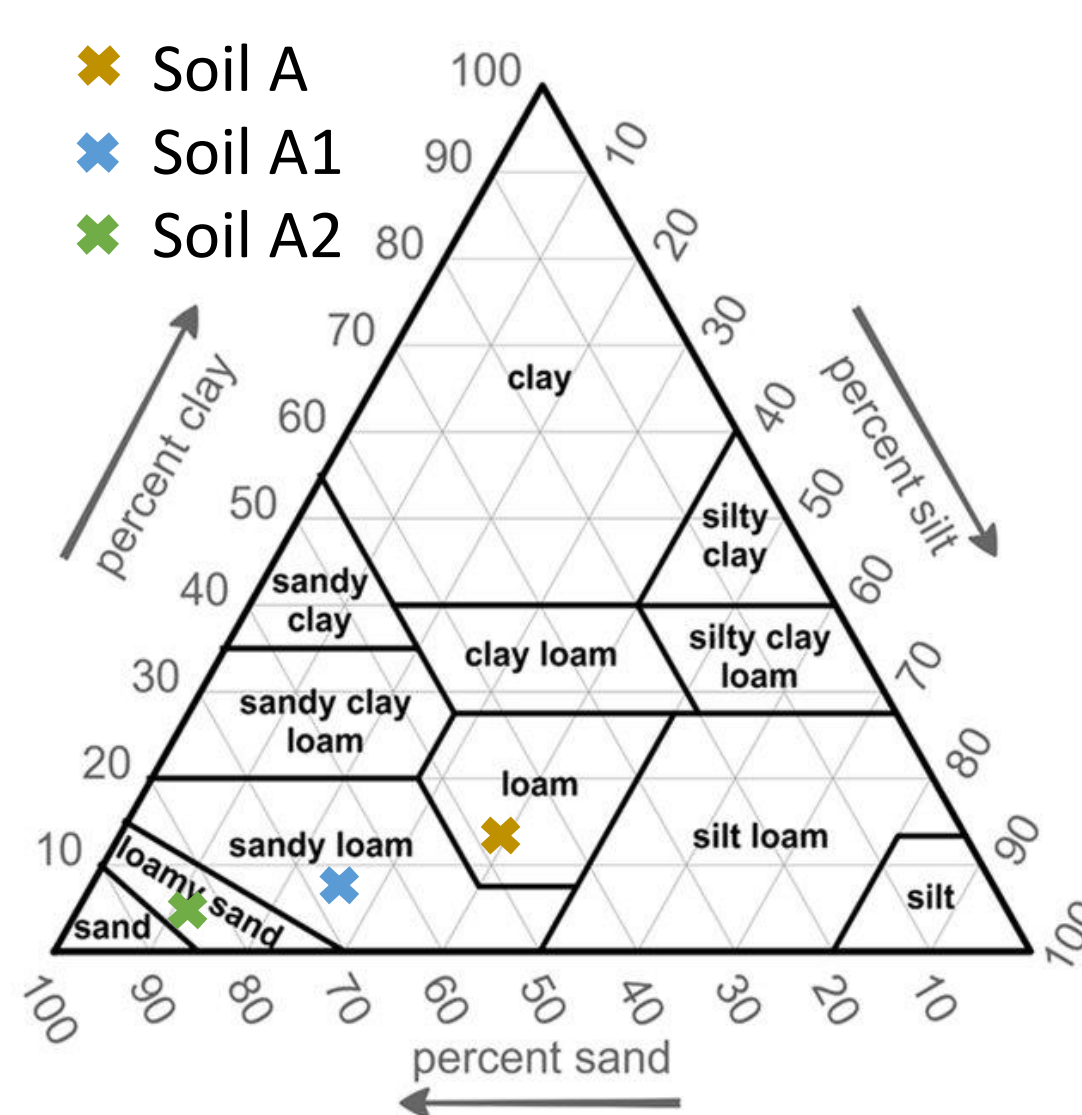
Climatic conditions : semi-arid climate

Sampling : depth = 0-20cm

Location of soil sampling in the region of Murcia

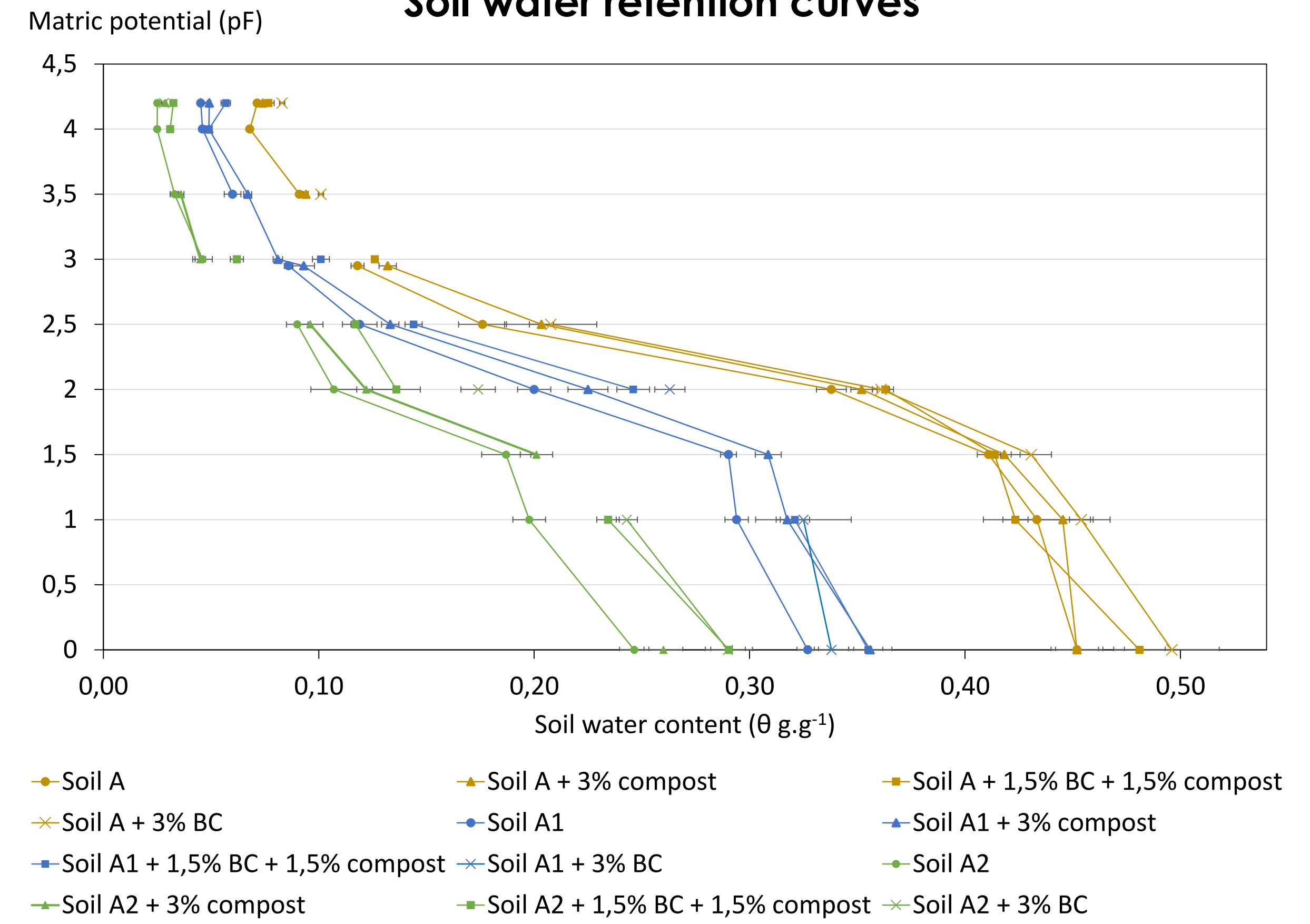


Soil texture classification (USDA)



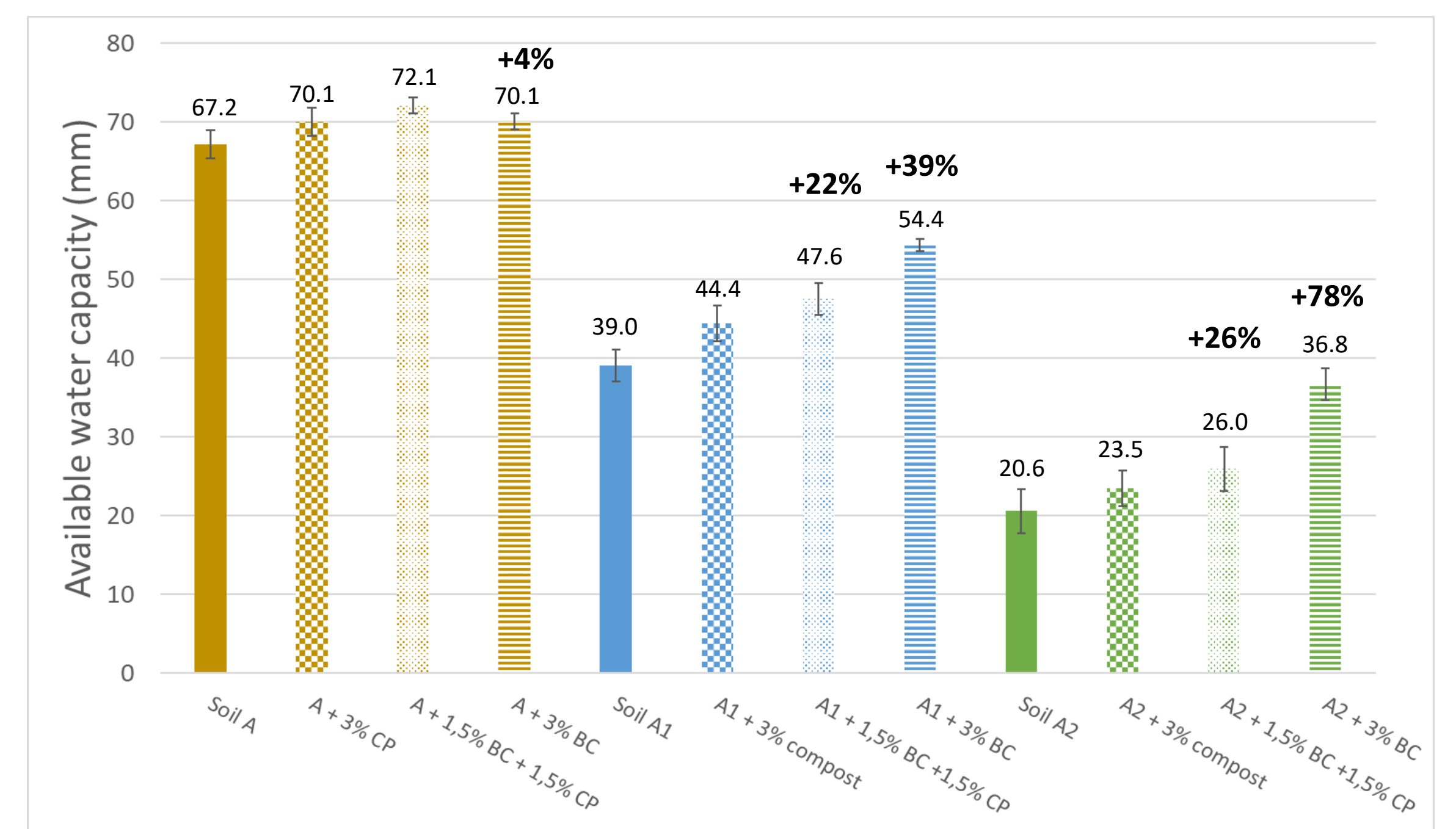
Soil water retention: results

Soil water retention curves



- Compost and biochar both increase soil water retention, whatever the pF
- Organic amendments have more significant effects on sand-enriched soils
- The increase ranged between 4 and 78% in the natural soil and in the sand-enriched soil A2, respectively
- Biochar alone has more beneficial effects than compost on the water retention properties of the soil

Soil available water capacity



In order to test the influence of soil texture on soil water retention, sand content was artificially increased by supplementing the natural soil with washed quartz sand:

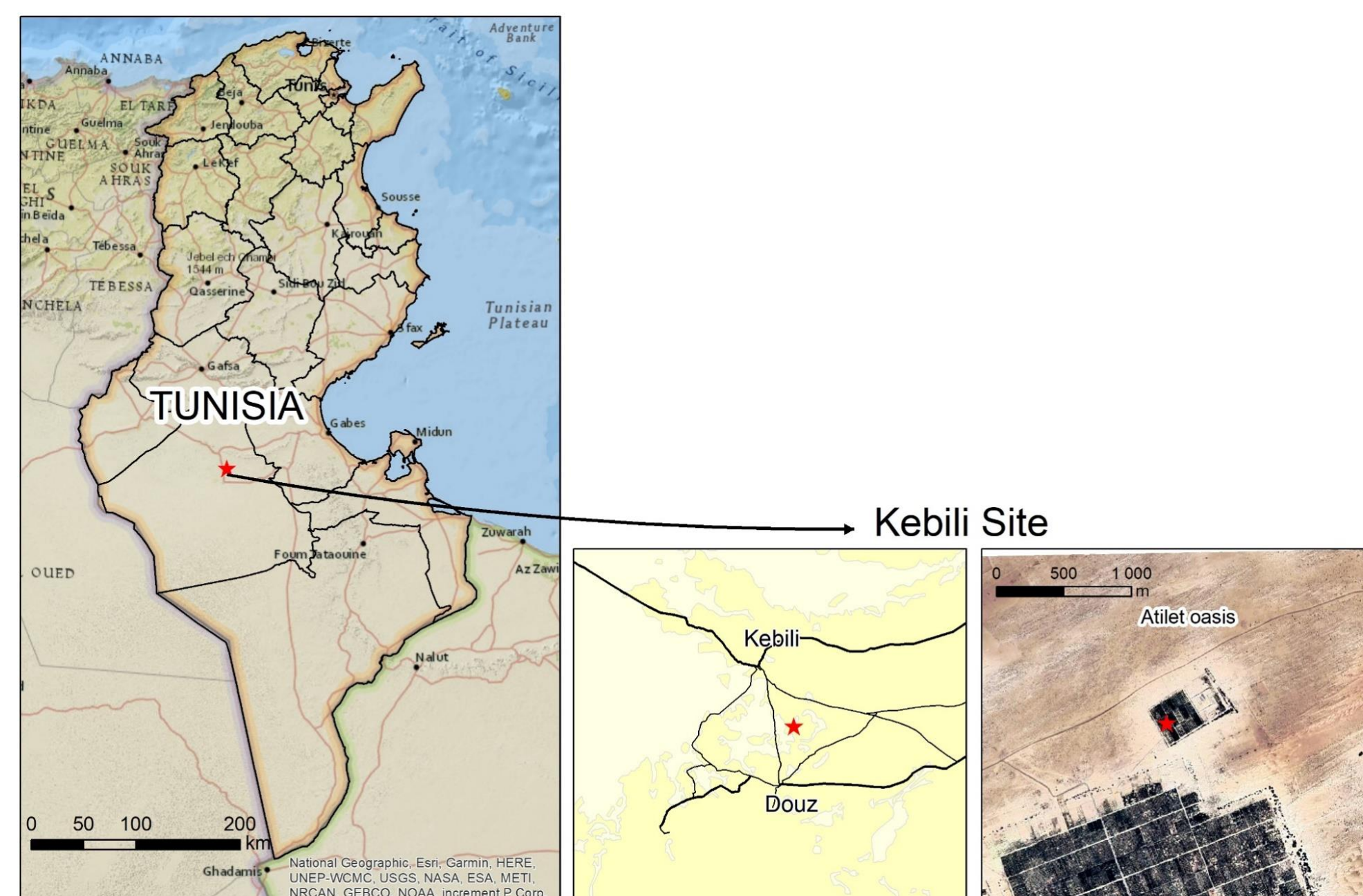
Soil A + 1/3 sand → soil A1 + 1/3 sand → soil A2

Treatments : (1) 60 t/ha compost, (2) 60 t/ha biochar and (3) mixture of 30 t/ha compost + 30 t/ha biochar

Water content was measured using pressure membrane apparatus at nine different matric potential (pF), ranging from the saturation to the permanent wilting point.

Methodology for soil incubations

Location of soil sampling in Tunisia



Location : continental oasis (El-Atilelet) in south Tunisia

Climatic conditions : arid climate

Sampling : depth = 2-20cm, no organic amendments

applied for ≥ 3 years. Soil was air dried and sieved to 1 mm.

Conditions : compost dose = 3%, temperature = 25°C,

humidity : pF=2.5

The following treatments were incubated for 90 days:

- (1) S (soil alone, control)
- (2) S + C
- (3) S + BC 0.75 %
- (4) S + BC 1.5 %
- (5) S + 0.75 % + C
- (6) S + BC 0.75 % + C*
- (7) S + BC 1.5 % + C
- (8) S + BC 1.5 % + C*

*pre-incubation of organic amendments

Soil incubations: results

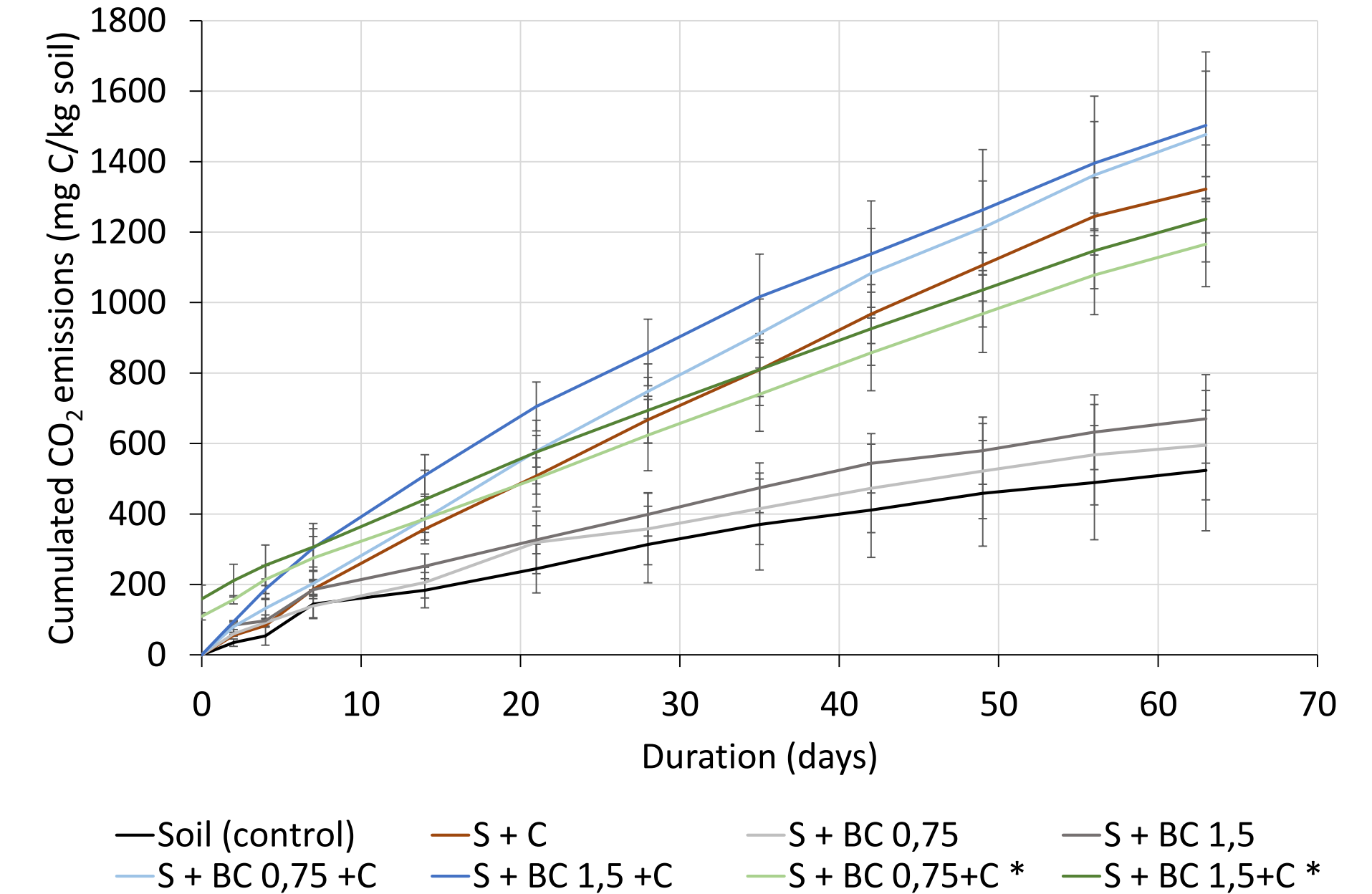
Physico-chemical properties of soil and organic amendments

Parameters	Unit	Soil	Compost	Biochar
Granulometry (decarbonated)	% clay	6	-	-
	% silt	10	-	-
	% sand	84	-	-
Bulk density	-	1,29	-	0,37
pH (water)	-	7,6	7,4	9,7
Electrical conductivity	mS/cm	2,0	20,2	7,6
Organic carbon	%	0,71	14,2	62
Total nitrogen	%	0,04	1,15	0,55
Mineral content	%	-	27,5	15,2

- Sandy and slightly alkaline soil
- Moderately saline soil with low organic carbon content

The compost is rich in salts and other minerals, which explains its low organic matter content.

Cumulated CO₂ emissions in biochar and/or compost amended soils



- High degradation rate of the date palm compost
- Reduction of mineralisation once organic amendments were pre incubated without soil

Conclusion

Compost and biochar improve the water retention capacity of soils with low clay and organic matter content. The compost used was not well stabilised during composting process.

Future work

Further investigations are planned to investigate the biochemical quality of the compost and the surface chemical properties of the biochar