Application of soil biological quality index to assess the sustainability of soil urban use classes: a case study

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INTRODUCTION

Soil biota play a major role in soil functioning that sustain plant growth. Changes in soil use have an impact on soil biology structure and composition with direct effect on the quality of organic matter decomposition, nutrient element cycling, porosity and infiltration, and other plant-growth functions (Fig. 1).

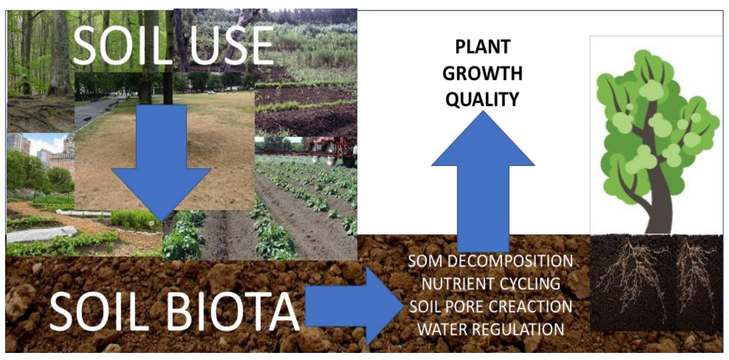

Fig. 1: Relations between soil use and soil functions

Urban soil use and management have crucial importance in urban planning, in order to support a rich biodiversity pool for more sustainable cities. Soil micro-arthropods are sensitive land cover and soil management which may cause a reduction in the abundance and diversity of soil communities. The biodiversity of soil micro-arthropods was compared to detect the soil biological quality index (QBS-ar) in soil samples from different urban green typologies. Results are discussed in order to evaluate the influence of urban soil use on quality soil-plant relations and sustainability of green area.

METHODOLOGY

Site description

The sampled areas were located in the city of Carpi (northern Italy, 44° 46'59"88 N, 10°52'43"32 E). A total of 19 sites were identified for sampling (Figure 2), belonging to four green areas types: urban parks (UP), urban forest (UF), roadside green (RG), arable soil (AS).

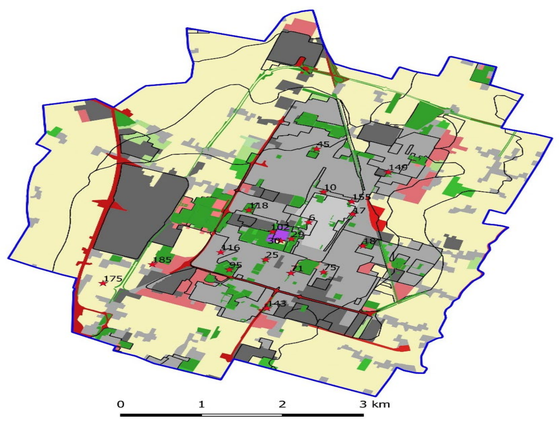

Fig.2: Site map with the point (red stars) of sampling area

References
Menta, C., Conti, F. D., Pinto, S., & Bodini, A. 2018. Soil Biological Quality index (QBS-ar): 15 years of application at global scale. Ecological indicators, 85, 773-780.
Parisi, V., Menta, C., Gardi, C., Jacomini, C., & Mozzanica, E. 2005. Microarthropod communities as a tool to assess soil quality and biodiversity: a new approach in Italy. Agriculture, ecosystems & environment, 105(1-2), 323-333.

The urban parks were distinguished in two classes: urban parks with low vegetation density (UPL) and urban parks with high vegetation density (UPH)(Fig. 3).

Fig.3: Aerial image of 4 types of green areas: a) Urban park with high vegetation density; b) Urban park with low vegetation density; d) agricultural field; d) roadside green

Soil quality index (QBS-ar)

The QBS-ar index combines the biodiversity of soil micro arthropods community with the degree of soil animals' vulnerability and provides information on the soil biological quality, which is an indicator of degradation (Parisi et al. 2005; Menta et al.2018).

Soil sampling

Soil sampling was done during spring (April-May) 2017, undisturbed soil samples of 100 cm^2 were collected and extracted within 48h. A Berlese-Tüllgren funnel was used for micro-arthropods extraction from each of the soil samples. The extracted specimens were observed under a stereomicroscope for identification at different taxonomical levels: classe for miriapoda, arachnida, order for insects and larvae.
The biodiversity of soil communities was evaluated using the number of observed taxa (NT), the Shannon-Weiner diversity index (H'). Soil quality was estimated by the Acari/ Collembola ratio (A/C) and the QBS-ar index.

RESULTS

A total of 1390 specimens of micro-arthropods belonging to 19 taxa were observed. Hymenoptera representing 44% of the extracted micro arthropods. The Collembola and Acari groups represented 14% and 12% of the total specimens respectively. The QBS index showed the highest mean value in UF samples ($p<0.001$) with significant differences to RG and UPL. A/C ratio results in clear separation between UF and other soil classes uses ($p<0.001$). H' index shows higher values in UF and low values found in UPL ($p<0.05$).

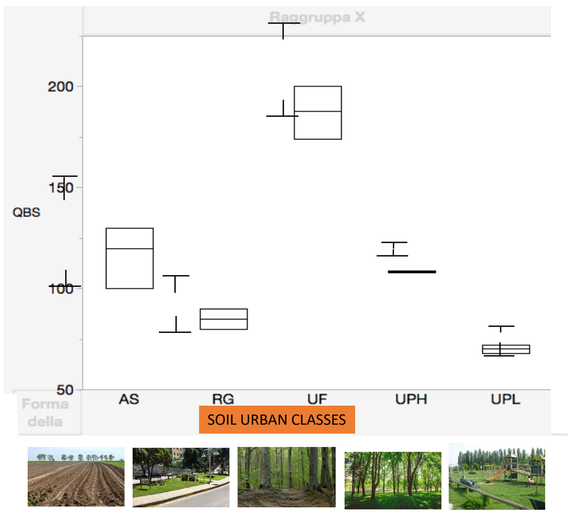

Fig. 4: QBS index score related soil use

Statistical analysis of the indices showed significant differences between almost all soil uses (Table 1). NT significantly higher values for UF while lower values are reported for UPL ($p<0.01$)

Table 1: Number of taxa (NT), Acari/Collemboli ratio (A/C), Shannon biodiversity index (H') for each soil use typology.

	UPL	UPH	UF	RG	AS
NT	4.5 ±0.48	7 ±0.48	14.5±0.84	6.33 ±0.68	9.33 ±0.68
A/C	0.27±0.09	0.34 ±0.09	0.97±0.15	0.29±0.12	0.27 ±0.12
H'	0.90±0.06	1.01±0.06	1.40±0.10	1.05±0.08	1.08±0.08

The QBS-ar index showed strong differences between soil use classes in the urban area that are also highlighted by biodiversity indices and soil quality indicator. **UF** showed the best values in term of biodiversity (H') and ecological equilibrium (A/C) and QBS-ar. **AS** and **UPH** show good values for QBS-ar, while the low values of A/C.**UPL** and **RG** shows the lowest values for QBS-ar.

DISCUSSION

UF and UPH show suitable trophic conditions to support micro arthropod communities in urban areas. The observed reduction in the number of taxa, quality and biodiversity of soil communities of UPL, compared to UPH could be affected by soil compaction, and low vegetal density. Human disturbances, might result in a decrease in nutrient content and related biological parameters in UPL and RG. AS results, demonstrate that soil tillage has lower disturbing effects on soil biota than anthropogenic factors in urban green areas. QBS-ar clearly described the sustainable of soil use in urban green areas. The information provided, could be useful to integrating soil management knowledge and practices into the urban green areas management.

Acknowledgments
This study was supported by the European project 'Save our Soils for Life' (SOS4LIFE, LIFE15ENV/IT/000225).