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**EDUCATION FOR
SUSTAINABLE CITIES**

Florence, 29th May 2025

editors

Francesca Ugolini, Serena di Grazia,

Irene Mari, Elena Palmisano

PROCEEDINGS

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Citizen Science and Education on the Importance of Urban Soils Protection (InTerra- HuMUS)

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Abstract

InTerra- HuMUS project engaged stakeholders of the Municipality of Sesto Fiorentino in participatory approaches aimed at supporting the protection of soil health. “InTerra” involved citizens, students, and stakeholders in collective activities like rural trekking, a citizen science initiative “underwear test”, and students in hands-on activities to raise awareness about soil functions and the threats leading to soil degradation.

Introduction

It is estimated that between 60% and 70% of European soils are degraded [1]. The European Soil Mission aims to address this issue not only by funding programs to reduce soil threats and improve soil health, but also by raising public awareness of the vital importance of soils [2]. Soil provides several key services, such as water regulation and storage, carbon sequestration, and support for biodiversity, ecosystems, and infrastructure—contributing to overall territorial sustainability [3].

To counteract threats such as urbanization and unsustainable human activities, the European project Healthy Municipal Soils (HuMUS) [4] engaged 20 municipalities and regions to foster constructive dialogue among four key stakeholder groups: farmers and food chain entrepreneurs, policy makers, researchers, and citizens. The goal was to support the creation of Territorial Management Agreements to protect and enhance soil health through participatory governance methods and tools.

Among these municipalities, Sesto Fiorentino (Tuscany, Italy) implemented the pilot project InTerra [5], which aimed to engage the four stakeholder groups in various

initiatives, while also involving younger generations through educational activities designed to raise awareness of soil properties, functions, and the essential services soils provide to communities, as well as the threats endangering soil health.

Methodology

Three types of engaging activities were carried out between October 2024 and June 2025 within the InTerra project:

1. Awareness-raising campaigns targeting citizens, including two rural treks and the citizen-science initiative “The Underwear Test” [6] which aimed to map soil health across the municipal area based on the degradation of white cotton fabric. A public event, Underwear Day, was held on November 16, 2024, during which citizens were invited to bring old, white, 100% cotton underwear to be buried in green spaces at a depth of 15–20 cm until May 2025. The buried fabric was later retrieved and examined to assess the degree of degradation.
2. Four focus groups with stakeholders were held to discuss the strengths of the municipal area, the challenges and threats to soil health in agricultural production, and the potential for creating an organic district. A SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) was conducted during these sessions.
3. Educational laboratories for all school levels were designed to foster broader awareness and consensus on the need to combat soil degradation. Hands-on outdoor workshops were organized for primary and secondary school students, focusing on soil physical, hydrological, chemical, and biological properties, and culminating in the construction of a worm house.

This paper focuses on the initiatives aimed at citizens, such as rural trekking, the collective citizen-science experiment, and school-targeted educational activities, all designed to enhance understanding and awareness of the importance of protecting and restoring soil health.

Results and discussions

These initiatives yielded a range of outcomes and achievements.

Rural trekking stimulated citizens’ interest and enhanced their knowledge of the Sesto Fiorentino area and its local farms. The trekking routes included visits to local producers and offered insights into simple methods for assessing soil health. Local farmers showcased their products and highlighted several challenges to sustainable farming in the area, including land fragmentation, limited availability of organic amendments to

improve soil fertility, and the high cost of organic certification. Despite these difficulties, the farmers expressed strong motivation and awareness regarding the importance of adopting more sustainable and health-conscious agricultural practices.

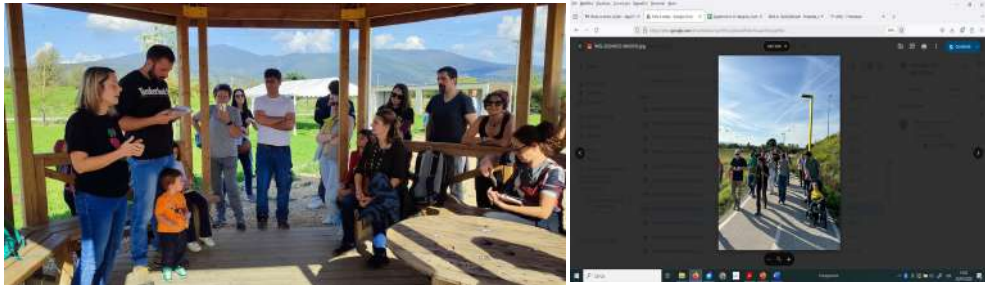


Figure 1. Rural trekking in the territory of Sesto Fiorentino with representatives of the municipality, farms and research institutions.

The **citizen-science initiative “Underwear Test”** aimed to map soil health across the municipal area by observing the degradation of buried cotton underwear. The rate of degradation depends on various factors, including soil type, climate, and the activity of soil organisms. In general, higher soil fertility corresponds to more advanced fabric degradation, due to the presence of a diverse community of organisms such as detritivores, bacteria, and fungi that contribute to the mineralization process. Several citizens took part in the collective experiment, bringing at the end of the project both the degraded underwear and corresponding soil samples to be analyzed using field-based tests.



Figure 2. Underwear Test to assess the soil quality.

The **educational activities** involved 75 students in hands-on experiences focused on soil properties, soil health, and the threats affecting it. Initially, students were invited to handle mineral particles of different sizes—such as sand, clay, and peat—to explore their tactile characteristics. Subsequently, the hydrological properties of these components were demonstrated using three transparent jars filled with different materials. A small amount of water was poured on top of each: water infiltrated quickly into the sand, was mostly absorbed by the peat, and took several minutes to infiltrate into the clay.

Soil aggregates were then examined for their structural stability by touch and immersion in water, where the release of air bubbles indicated the presence of internal air spaces. Soil pH - an important factor influencing nutrient availability - was tested by mixing soil with distilled water and applying litmus paper.

Processes of soil erosion and formation were illustrated using a simulation model that compared the impact of rainfall of varying intensities on vegetated versus bare soil on a slope. Finally, students were divided into three groups: one collected earthworm, another dead leaves, and the third small stones. These materials were used to construct an “*earthworm house*” in a plexiglass box, layering stones, soil, sand, and leaves, followed by the addition of earthworms and organic material. The earthworm houses were returned to the classrooms for further observation of earthworm growth, feeding, and movement behavior.



Figure 3. Photos on hands-on activities on soil properties, erosion, and the construction of a “earthworm house”.

Conclusions

All these initiatives led to the involvement of the local community of all generations in understanding more about soil and its functions and services. Participants enjoyed the opportunity to learn about scientific methods and the properties of the soil through

different simple experiments but also to know more about issues that threaten soil health such as urbanization, conventional agriculture, climate change and the problems encountered by farmers.

Acknowledgements

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