

FROM IMPACTED TO REUSABLE: DEFINING THE ECOLOGICAL POTENTIAL OF BIOREMEDIATED SOILS

GT 11. Soil Degradation, Desertification, Contamination - Conservation, Mitigation, Remediation / GT 04. Soil Biology

Davide Rossi*, Lorenzo Federico, Sara Villa, Andrea Franzetti

Università degli studi di Milano-Bicocca, Milano, Italy

* d.rossi39@campus.unimib.it

ABSTRACT TEXT

Bioremediation is a sustainable, low-impact approach to managing contaminated soil. It enables the restoration of ecological functionality and the incorporation of these materials into the circular economy. However, for remediated soil to be safely reused, it is essential to develop a biological quality classification system that considers the soil's chemical and physical properties, as well as its biological responses.

This study presents an integrated approach to evaluating the quality of bioremediated soils, combining basic agronomic parameters with a structured ecotoxicological testing framework. The aim is to develop a reproducible, step-by-step methodology for classifying soil quality into six levels (Classes A to F), with each level corresponding to a set of potential applications in urban green infrastructure, landscape design and ecological restoration.

The agronomic potential was assessed using parameters such as pH, texture, total and organic carbon, nitrogen, total, organic and available phosphorus, and calcium carbonate. These parameters influence soil-dwelling organisms and support the interpretation of ecological performance.

The ecotoxicological workflow involves two phases using two standard soil indicator species: *Eisenia fetida* (earthworms) and *Folsomia candida* (springtails). Phase 1 comprises avoidance tests that evaluate the species' ability to detect and avoid unsuitable conditions. Soils are then assigned to preliminary quality classes (F, C or B) based on this. Phase 2 includes reproduction tests to assess chronic sub-lethal effects and refine the classification into the final classes (A to F), which more accurately reflect ecological functionality.

Phase 1 of this protocol has already been tested using samples collected from two sites undergoing dynamic biopile remediation. Each sample was tested in replicates, together with negative control. Transparent glass vessels (15×8 cm) were divided by a Plexiglas sheet into two compartments: one containing the soil sample and the other containing sieved reference LUFA 2.2 soil (both to 2 mm). In the controls, both halves contained LUFA 2.2 soil. After removing the divider, organisms were placed in the center and exposed to a 16:8 light: dark cycle.

Results were expressed as Net Response Percentage (NR%). Overall, the soils that were tested exhibited a broad range of responses. While some soils showed full compatibility with both species, others indicated moderate to strong limitations, about avoidance behavior. These biological endpoints could correlate with specific chemical and physical soil characteristics. This suggests that a combined assessment provides a more reliable evaluation of the soil's ecological readiness for reuse.

The classification system supports the development of reuse strategies that align with the potential of remediated soil, thereby promoting transparency, ecological integration and sustainable land management.

REFERENCES

UNI EN ISO 17512-1

UNI EN ISO 17512-2

SYMBOL	MEANING
✓	The soil was NOT limiting for the species
✗	The soil was limiting for the species

