

multi-Risk sciEnce for resilienT commUnities undeR a changiNgcLimate

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AUTHORS

Valentina Catania (UNIPA); Paola Quatrini (UNIPA); Gaspare ViViani (UNIPA); Daniele Di Trapani (UNIPA); Francesco Castelli (UKE); Tommaso Calandrelli (UNICA); Daniela Medas (UNICA); Giovanni De Giudici (UNICA); Chiara Alisi (ENEA); Patrizia Paganin (ENEA); Alessandro Casasso (PoliTO); Barbara Ruffino (PoliTo); Rajandrea sethi (PoliTo); Villani Federico (EniRewind); Silvia anna Frisario (EniRewind), Silvia Breda (CA-FOSCARI), Petra Scanferla (CA-FOSCARI), Giulia Meneghin (Ca' Foscari); Giorgia Di Carlo (Ca' Foscari); Vincenzo Sergio Vespo (PoliTO), Guido Musso (PoliTO); Andrea Dominijanni (PoliTO)

TECHNICAL REFERENCES

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Project Coordinator	Domenico Calcaterra UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II domcalca@unina.it
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* PU = Public

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ABSTRACT

Task 5.4 aimed to advance sustainable remediation approaches for contaminated soils, groundwater, and mining-impacted areas through an integrated combination of laboratory experiments, field investigations, numerical modeling, and sustainability assessment. The overarching objective was to develop, test, and evaluate innovative technologies capable of reducing contaminant mobility, enhancing degradation processes, and supporting long-term environmental recovery, while ensuring technical feasibility and alignment with sustainability principles.

The activities undertaken addressed three complementary domains. First, new theoretical and numerical models were developed to simulate non-isothermal water flow, vapor transport, and contaminant migration in unsaturated porous media, providing predictive tools essential for understanding pollutant behaviour and for designing effective interventions. Second, experimental work at both laboratory and field scale supported the development and performance assessment of bioremediation and phytostabilization strategies. These included the isolation and characterization of microbial strains capable of degrading hydrocarbons and chlorinated solvents, the design of microcosm studies to evaluate biostimulation and bioaugmentation, and the implementation of a mine-tailings experimental field to test bioaugmentation, amendments, and biogeochemical barriers for reducing metal and metalloid dispersion. Third, the task established a structured sustainability-assessment framework, supported by a review of international regulatory approaches and the definition of environmental, social, and economic indicators suitable for evaluating remediation technologies ex-ante.

Overall, the results demonstrate the feasibility and applicability of the developed methodologies and technologies, offering both operational tools and conceptual frameworks to improve the assessment of remediation performance. The outcomes contribute to the advancement of sustainable, science-based remediation solutions and provide a foundation for risk reduction and regeneration of contaminated, brownfield, and mining-affected sites.

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