LIFE-SEDREMED.EU

LIFE20 ENV/IT/000572

# LIFE sedremed

ENHANCED BIOREMEDIATION
OF CONTAMINATED MARINE SEDIMENTS

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# Project & Partnership Information

The LIFE SEDREMED project is co-funded by the EU to develop innovative solutions for the in-situ decontamination of polluted marine sediments

**DURATION:** 01/10/2021 - 30/06/2025
**PROJECT LOCATION:** Bagnoli (Ex-industrial area of steel, asbestos, cement, fertilizers and pesticides), Naples (IT)
**FUNDING:** €2,591,866 Co-financed by the EU for 55%

COORDINATOR

STAZIONE ZOOLOGICA ANTON DOHRN

SITE MANAGER

INVITALIA

TECHNOLOGY PROVIDERS

IDRABEL

EKOGRID

MONITORING

UNIVERSITÀ POLITECNICA DELLE MARCHE

Isodetect

COMMUNICATION AND REPLICATION

NISIDA ENVIRONMENT

# Enhanced bioremediation of contaminated sediments in coastal areas of former industrial areas.

LIFE SEDREMED aimed at developing an innovative solution for the decontamination of polluted marine sediments.
It tested the effectiveness of a methodology based on bioremediation using microorganisms bio-fixed on mineral supports, combined with electric current transmission through electrodes, to accelerate the degradation of organic contaminants and fixation of heavy metals.

The intervention aimed to reduce the concentration of organic pollutants and the bioavailability of heavy metals.

The project enabled the testing of an innovative approach to reduce environmental risks and lower the costs associated with dredging and off-site treatment and disposal of contaminated sediments.

# The six phases of the project

**1. Preliminary sediment analysis**

The project began with a thorough sampling campaign in two areas off the coast of Bagnoli: one heavily contaminated, and one with relatively lower contamination levels. Sediments were collected and analyzed to determine pollution levels from heavy metals and hydrocarbons, providing the scientific basis for the intervention.

**2. Tank tests (mesocosms)**

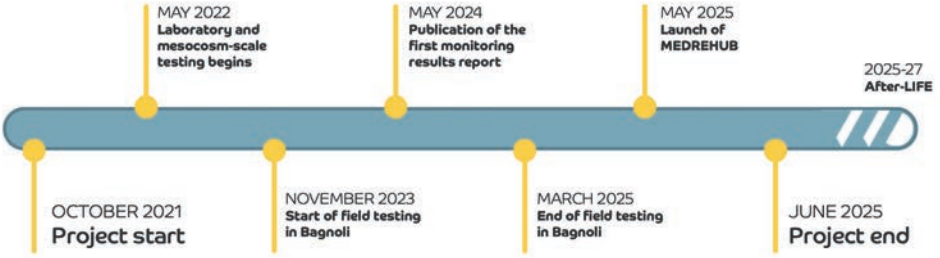
The collected sediments were sent to laboratories for testing in mesocosms: customised tanks simulating real marine conditions. Here, the combination of IDRABEL (microbial biofixation) and EKOGRID (electrostimulation) technologies was tested to define the most effective intervention protocol.

**3. Field installation**

In November 2023, the technologies were installed in a 100 m² marine demonstration area.
The setup allowed testing of electrostimulation alone and in combination with microbial treatment, assessing their effectiveness and stability in real conditions.

**4. Integrated monitoring**

Chemical, microbial, and ecotoxicological monitoring was executed during and after the installation. Biodiversity and ecosystem functioning was also monitored and finally, Life Cycle Assessment (LCA) was performed to compare the impact of LIFE SEDREMED approach to conventional dredging and disposal.

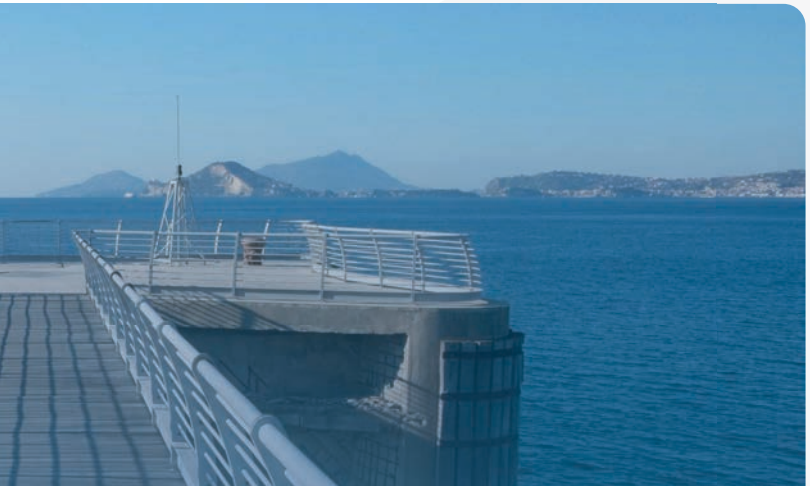



## 5. Communication and public engagement

The project actively promoted scientific dissemination and public engagement through events, workshops, articles, guided tours, and international conferences. Special focus was given to the Bagnoli community through participatory workshops and a dedicated event.

## 6. Creation of the MEDREHUB

As a project legacy, the MEDREHUB – Mediterranean Remediation and Innovation Hub – is being established at the Anton Dohrn Zoological Station. The center will serve as a permanent space for research, training, and dissemination of sustainable solutions for the remediation of marine sediments in the Mediterranean.



# Demonstration site and context

### Industrial development and its impact on the community

In Bagnoli, industrial development accelerated significantly starting in 1904, following the Special Law for Naples, which led to the construction of a large steel plant. The steel mill rapidly expanded, employing over 7,000 people by 1954. In the 1980s, the deindustrialization process began. Despite major restructuring investments, the blast furnace was permanently shut down in 1990. The consequences for the local population were severe: thousands of families lost their main source of income, and the surrounding area remained heavily polluted.

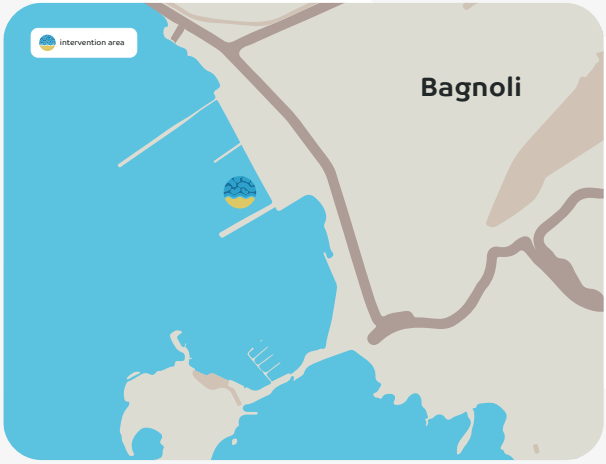



Fig 1: The most contaminated area was chosen as the key one to tackle

### Environmental impact and decontamination

The coast of Bagnoli has suffered from long-term accumulation of contaminants in marine sediments: aliphatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins (PCDDs), asbestos residues, and heavy metals like arsenic, lead, zinc, cadmium, and mercury. In addition, untreated urban wastewater discharges worsened the environmental situation. Pollution has hindered the area's social and economic development and caused severe impacts on marine biodiversity, posing potential risks to human health.

# Technologies and challenges

**The Idrabel and Ekogrid technologies were combined for the first time in a marine environment.**

## Idrabel technology

Idrabel's technology is based on an innovative biofixation method – a technique that immobilizes microorganisms on natural mineral supports.
This approach ensures longer microbial life, higher pollutant degradation efficiency, and good adaptability to open environments, such as surface waters and river or marine sediments.
The mineral supports used (marine-origin calcium carbonate and zeolites) are natural materials that enable to fix heavy metals and avoid the use of synthetic materials in decontamination processes.

## Ekogrid technology

The EKOGRID™ Electrokinetic Remediation solution uses electrokinetic and electrochemical reactions to enhance bioremediation and break down organic pollutants in soil, groundwater, and sediments, both in-situ and ex-situ.
EKOGRID™ generates reactive radicals on sediment particle surfaces through electrochemical phenomena, and uses electrokinetic and electro-osmotic processes to increase the availability of organic pollutants, making them more accessible to bioremediation, chemical degradation, or mechanical removal.
The installation aimed to enhance the degradation efficiency already provided by the microorganisms used in Idrabel's technology.

### Challenges encountered

- Simultaneous operational adaptation of both technologies in the marine environment.
- Need to calibrate electrical parameters to avoid interfering with microbial activity.
- Marine conditions (currents, salinity) affect system efficiency.
- Logistics and timing constraints for installation in a heavily regulated coastal area.
- Very high contaminants concentrations, uneven distribution of contaminants, and low oxygen availability in sediments
- Compactness of sediments to be treated.

# Monitoring technology

The monitoring activities included the analysis of chemical contaminants, microorganisms potentially involved in decontamination processes, ecotoxicological assays, and evaluation of possible positive or negative effects on biological components of the marine ecosystem.

The analysis of biodiversity and ecosystem functioning during the treatments ruled out potential negative impacts, supporting the good environmental sustainability of the technologies that were tested.

In order to assess microbial activities potentially useful for sediment bioremediation, ISODETECT has developed an innovative device (BACTRAPS), i.e., capsules containing "tagged" substances capable of detecting specific microbial decontamination processes.

The LCA (life cycle analysis) confirms that the LIFE SEDREMED scenario would be the most sustainable: according to the analysis it would be able to reduce environmental impacts by up to 87% compared to landfilling sediment.

Although the LIFE SEDREMED approach requires a higher initial investment, it would turn out to have very low operating costs. Investment in further studies will be necessary to confirm its technical effectiveness and to collect more precise data.

# Results achieved

Analyses have shown the presence of microbial communities capable of degrading pollutants in a highly efficient manner when properly stimulated.

Monitoring activities have shown that natural processes of microbial degradation of contaminants are already occurring, although at a low intensity. Through experiments such as LIFE SEDREMED and further studies, it will therefore be possible to achieve a decisive acceleration in the degradation of pollutants.

On-site operations were complicated by the challenges of adapting the technologies to an underwater marine environment (such as salinity and currents) and were further hindered by damage to the installations.

The technologies have demonstrated good efficiency in removing heavy metals such as Cadmium and Zinc from contaminated sediments.

However, regarding the degradation of organic compounds (e.g., hydrocarbons), due to the very high concentrations of pollutants, the heterogeneity in contaminant distribution, and the compactness of the sediments, the technologies installed have so far only been able to achieve the initial stages of a degradation process.

The project partnership will continue working in the coming years to further adapt and refine the proposed technologies, also evaluating other sustainable approaches to address the remediation and management of contaminated sediments.

# Mediterranean Remediation and Innovation Hub (MEDREHUB)

The Mediterranean Remediation and Innovation Hub (MEDREHUB) is being launched as a center of innovation, dedicated to advancing sustainable solutions for coastal remediation and the management of contaminated marine sediments. While rooted in the achievements of the LIFE SEDREMED project — particularly in the area of bioremediation — MEDREHUB goes beyond this approach to embrace a broader, more integrated vision of environmental recovery and resilience along the Mediterranean coastline.

Hosted at the Stazione Zoologica Anton Dohrn in Naples, MEDREHUB will serve as a regional and international reference point for research, innovation, and knowledge exchange on coastal remediation and contaminated sediment management.

Recognizing that sustainable sediment management requires collaboration across scientific, regulatory, and societal domains - through partnerships with academic institutions, government agencies, industry stakeholders, and civil society - MEDREHUB aims to foster interdisciplinary dialogue and drive forward practical solutions to tackle legacy pollution and marine habitat degradation.

Key activities will include applied research, pilot projects, technical training, stakeholder consultations, and support for the development and harmonization of environmental policies at national and EU levels. By doing so, MEDREHUB aspires to strengthen the resilience of both marine ecosystems and coastal communities, contributing to a cleaner, healthier, and more sustainable seas.

## ACTIVITIES OF MEDREHUB

1. TECHNICAL TRAINING
2. PARTNERSHIPS CREATION
3. STAKEHOLDERS ENGAGEMENT
4. POLICY IMPROVEMENT
5. RESEARCH PROJECTS INCUBATOR

# After-life plan

**Research and Innovation in Sustainable Sediment Management**

The Hub will serve as a collaborative platform for projects on remediation technologies, biodiversity restoration, and sustainable sediment management, with the goal of fostering innovation and supporting future research proposals under the Horizon Europe and LIFE programmes.

**Dissemination of Results Achieved**

The knowledge acquired over the years will be shared through reports and scientific publications, accessible both to experts and the general public. Part of the output will focus on the sustainability and potential cost-effectiveness of the LIFE SEDREMED and other in-situ approaches, compared to other commonly used methodologies.

**Stakeholder Engagement and Policy Influence**

The project aims to expand collaboration with policymakers, private sector partners, and civil society, promoting favorable policies for coastal remediation and sustainable sediment management. This will include organizing events such as conferences, technical workshops, and webinars.

**Market Analysis and Financing Strategy**

An in-depth analysis of the coastal remediation and contaminated sediment management market will be conducted, with a particular focus on the replicability and scalability of the approach in Europe and the Mediterranean. A hybrid financing strategy will also be developed to secure resources for both current and future activities.

**The success of MEDREHUB depends on its partners.**

**Join the community.**
**Join the action!**

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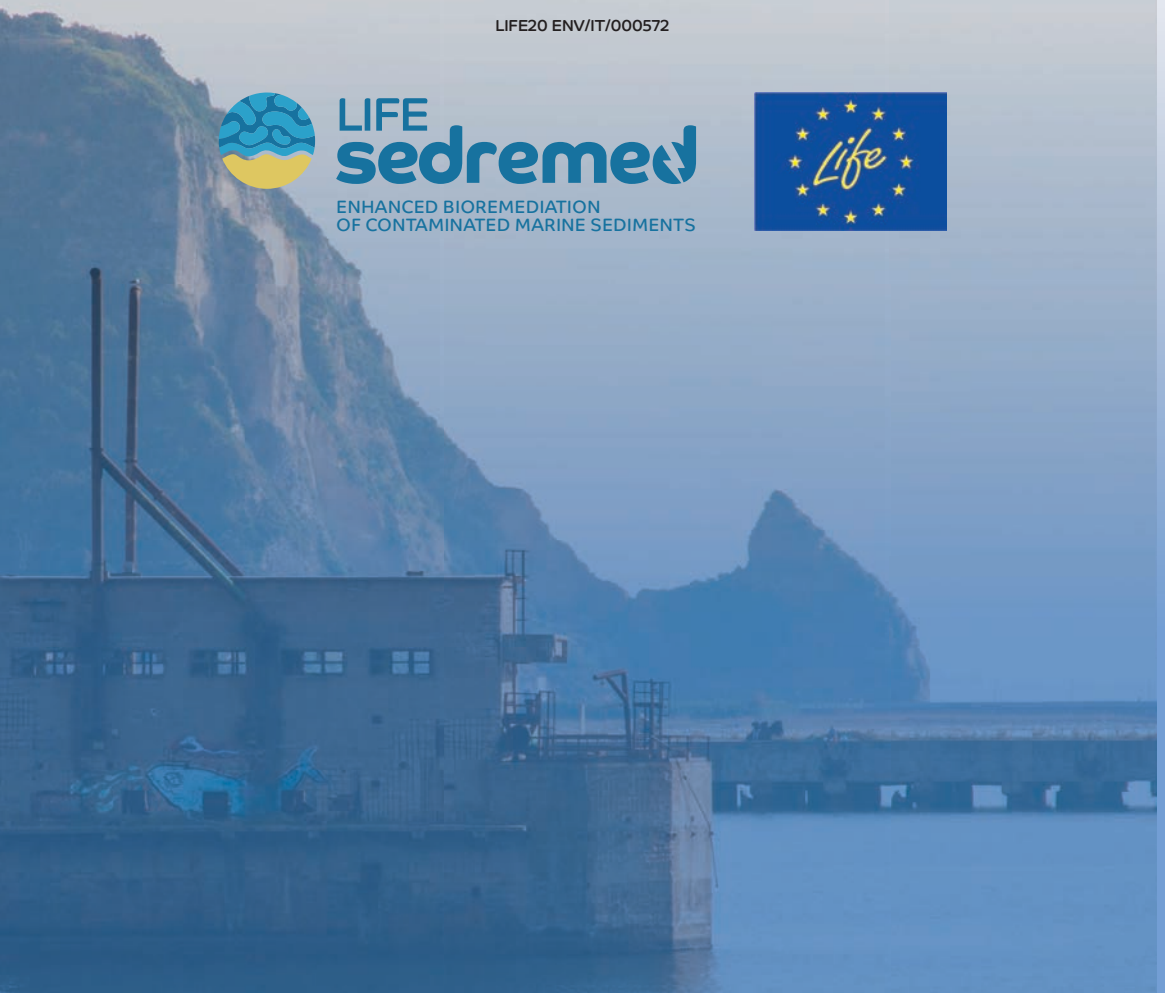

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The LIFE SEDREMED project is co-funded by the LIFE Programme of the European Union under contract number LIFE20 ENV/IT/000572.

The LIFE programme is the EU's funding instrument for the environment and climate action. Since 1992, it has co-financed more than 5.500 projects including 120 projects for the protection, remediation and restoration of the marine environment. The LIFE programme represents a key instrument for the implementation of the EU Green Deal.