MOBILES

NEWSLETTER N. 2

09/2025

MONITORING AND DETECTION OF BIOTIC AND ABIOTIC POLLUTANTS BY ELECTRONIC, PLANTS AND MICROORGANISMS BASED SENSORS

The **MOBILES project** is an innovative project funded by the European Union under Horizon Europe Programme. By developing advanced electronic and organism-based biosensors, the project aims to detect and monitor harmful organic chemicals, antimicrobial-resistant bacteria, and pathogens across soil, water, and air. Furthermore, soil metagenomic analysis will be conducted on contaminated soils across Europe, and a metagenomic database will be constructed in order to identify a pool of genes linked to soil specific soil pollutants.

OUR VISION

MOBILES is dedicated to safeguarding environmental health through real-time, portable diagnostic tools, enabling rapid and precise detection of biotic and abiotic pollutants is soil, water and air.

KEY OBJECTIVES

- **Next-generation electronic biosensors:** Eco-friendly devices to detect organic chemicals, antimicrobial-resistant (AMR) bacteria, and pathogens.
- **Organism-based biosensors:** Usage of genetically engineered plants, bacteria, and marine diatoms to monitor organic and anorganic pollution.
- **Metagenomic analysis:** Comprehensive soil microbiota analysis in polluted areas across Europe to uncover gene clusters and genetic diversity. This helps assess microbial functions and provides genetic markers to quick evaluation of soil and land health.
- **Environmental performance testing:** Validating biosensors using real-world samples from polluted sites.
- **Safety assurance:** Rigorous evaluation of environmental impacts associated with these modified organisms and innovative devices.

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WORK PACKAGES

ELECTRONIC BIOSENSORS FOR ENVIRONMENTAL MONITORING (WP1)

A team of researchers, led by INRAE (National Research Institute for Agriculture, Food and Environment, France), is developing advanced electrochemical biosensors to detect pollutants such as pesticides, pathogenic bacteria, antimicrobial resistance genes, and spores in soil, water, and air. These sensors will integrate conductive materials and biological components to ensure accuracy, stability, and sensitivity to various contaminants.

Three partners are currently working on developing an electrochemical sensor for *Bacillus cereus* spore detection: the University of Bordeaux, INRAE, and the University of Belgrade. The spores of *Bacillus cereus* are dormant bodies that carry all the genetic material but do not have an active metabolism. As such, they are ubiquitous and can be found in air, water, soil, food, raw materials, and processing environments. Spores are much more resistant to heat, dryness, and other harsh environmental conditions than the vegetative form, and therefore serve as a means of survival during unfavourable conditions. When the environment becomes favourable, spores germinate into vegetative *Bacillus* cells. Most spore-forming bacteria are harmless, but some produce toxins. INRAE has validated several specific aptamers that bind to the exosporium of *B. cereus*. These aptamers are used to build biosensors.

Status: In progress

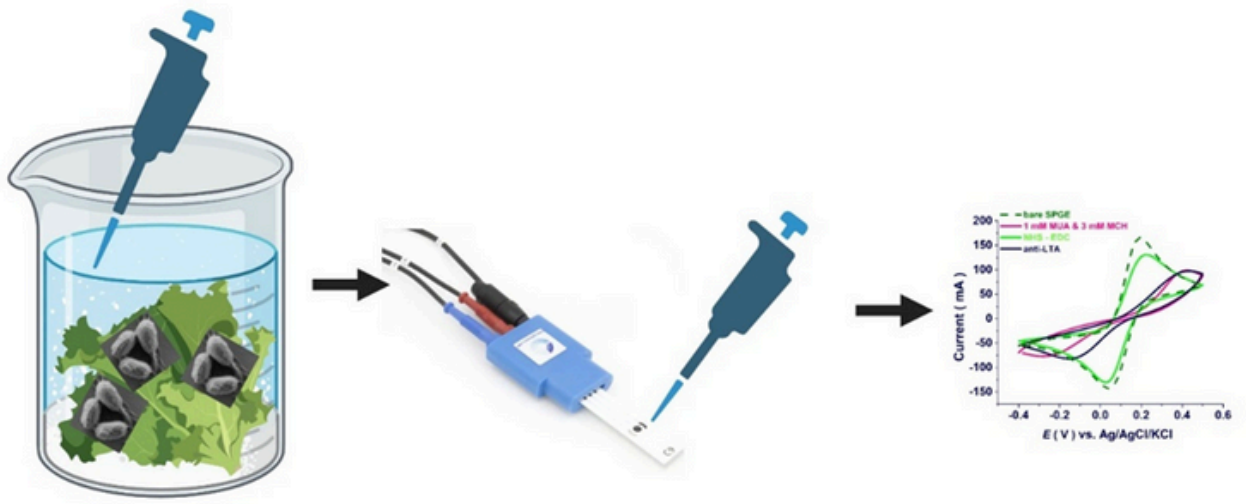

Figure 1: Detection of Bacillus cereus spores

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DETECTION OF POLLUTANTS VIA BIOTIC SENSOR (WP2)

Under the leadership of the University of Rome (UR), scientists are developing advanced biosensors to detect environmental pollutants such as heavy metals (e.g., arsenic), pesticides, antibiotics, and microplastics. These sensors will help monitor soil, water, and air quality using biological components like plants, bacteria, and diatoms (a type of algae).

Several lines of the *Arabidopsis* plant with enhanced arsenic (As) accumulation have also been established. Furthermore it has been observed that plants with a greater number of cortical layers, such as *Cardamine hirsuta*, exhibit higher resistance to As, and the UR team plans to introduce an As sensor into this species as well. In another plant model *Pteris vittata*, both sporophytes and callus tissue have been successfully obtained, marking an important step toward establishing a transformation protocol. Plasmid vectors for transforming *Pteris vittata* have already been constructed. Within WP2, a luminescent "fingerprint" system based on bioluminescent bacteria has been developed and tested against various substances. At the same time, a continuous biosensor platform for water quality monitoring has been advanced. This platform is intended to integrate both the luminescent bacteria and their unique fingerprints to enable detection of environmental contaminants. Additionally, marine diatoms are being cultivated for the detection of nano- and microplastics, with spectroscopic techniques—including fluorescence, Raman, and FTIR—applied to study their dynamics.

Status: In progress

METAGENOMICS DATABASE AND FULLY-SEQUENCED POLLUTED SOIL MICROBIOTA (WP3)

Under the leadership of CNR (National Research Council of Italy), researchers are studying bacterial/microbial community in the soil to better understand how pollution affects them and how they can help restore damaged land. By analysing the genetic material of these microbes, researchers aim to identify key biological markers that indicate soil health and can guide soil rehabilitation efforts. These findings will help develop new strategies for managing contaminated environments more effectively.

COLLECTING SOIL SAMPLES ACROSS EUROPE

The first round of samplings in the six partner countries (Poland, France, Italy, Germany, Greece, and Cyprus) is now completed successfully. All sampled soils from the chosen sites were brought to Poland for standardized processing. The second sampling round is schedule in the second half of October 2025. After careful sieving, DNA and RNA extractions were performed to obtain high-quality nucleic acids ready to be sequenced. Aliquots of soil samples are shipped to the partner in Belgrade University (Serbia) to perform a deep chemical and pollution analysis.

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SEQUENCING SOIL SAMPLES

Subsequent to the extraction step, DNA and RNA samples were submitted to an external company for sequencing. For DNA, Illumina-based 16S metabarcoding is being performed to describe microbial community structure between samples. For RNA, RNA-seq sequencing will generate data for metatranscriptomic analyses, allowing us to examine the functional activity of soil microbiota in response to pollutants.

BIOINFORMATICS INFRASTRUCTURE AND PIPELINE

Parallel to this, WP3 researchers are working closely together with the University of Navarra to establish a dedicated server and database facilities to host and process the sequencing data. The bioinformatics pipelines are shown in *Figure 2*.

FUTURE PERSPECTIVES

The integration of sequencing, chemical soil analysis, and advanced bioinformatics will paint a complete picture of the response of soil microbial communities to pollution. The resulting metagenomic and metatranscriptomic database, set up in Navarra, will offer an efficient instrument for the identification of microbial indicators of soil health and the trajectory of new strategies for environmental remediation.

Status: In progress

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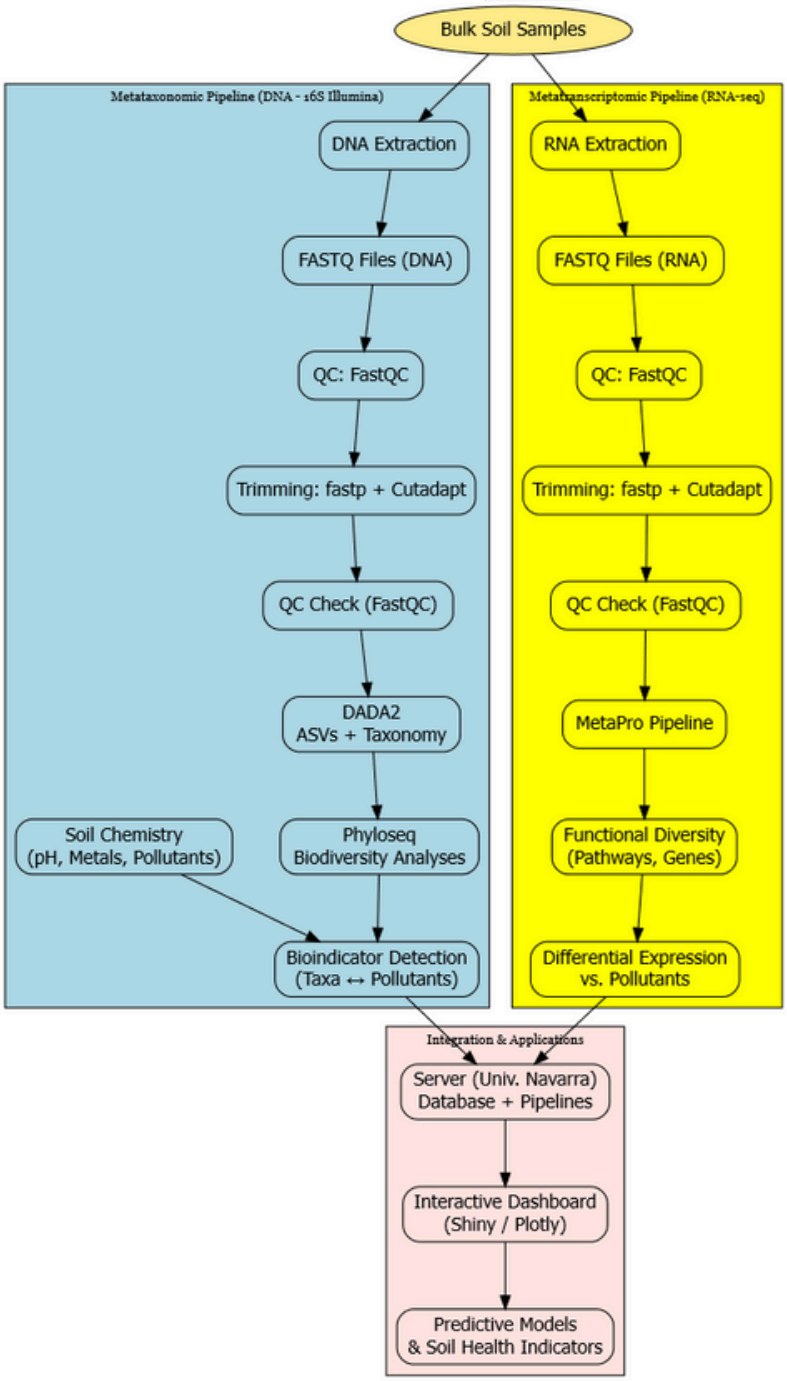

Figure 2: Workflow of MOBILES WP3 metagenomic and metatranscriptomic analyses

Bulk soil samples are processed for DNA (blue pipeline) and RNA (yellow pipeline) extraction. DNA is sequenced for 16S metabarcoding and analysed with DADA2 and Phyloseq to assess microbial community composition and biodiversity, combined with chemical soil data to identify potential bioindicators. RNA is sequenced for RNA-seq and analysed with the MetaPro pipeline to study functional diversity and pollutant-responsive genes. Results from both pipelines are integrated on the Navarra University server to build the MOBILES database, enabling visualization, interactive dashboards, and predictive models for soil health.

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ENVIRONMENTAL PERFORMANCE AND SAFETY OF DEVELOPED ORGANISMS, AND PACKAGING OF SENSOR DEVICES (WP4)

Scientists are working on improving biosensors—specialized devices that detect environmental pollutants. These biosensors use biological components, such as enzymes and microorganisms, to identify harmful substances in soil and water. To ensure their effectiveness in real-world conditions, researchers are also focusing on practical issues such as proper packaging, durability, safety, and performance testing. This activity will be supervised by RICPA (Research and Innovation Center Pro-Akademia, Poland).

Since some biosensors involve genetically modified bacteria and plants, researchers must carefully evaluate their potential risks. They will conduct controlled laboratory tests to study how these organisms interact with the environment and whether they could affect non-target species like insects and soil microbes. Scientists will also assess the possibility of gene transfer from modified organisms to natural ecosystems, ensuring their safe use. This work just recently started and their facility is now registered for safe work with GMOs. They are currently preparing the contained-use application for GMO (bacteria), which includes conducting a preliminary, literature-based environmental risk assessment, covering problem formulation, organism characterization, and related aspects.

Status: Just started

COMMUNICATION AND MANAGEMENT OF THE PROJECT (WP5+WP6)

This research project is not only about scientific discoveries but also management of the project itself and about sharing knowledge and engaging with different groups of people. The project team is working to ensure that the project is visible and its results will reach policymakers, businesses, researchers, and the general public, helping to improve environmental protection efforts.

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MOBILES established its own ecosystem of communication network via dedicated:

1. Website
2. Linked-In account
3. YouTube channel
4. Zenodo repository

News on published papers, experimental work, events where MOBILES partners participate, public deliverables and other public activities are constantly published on such communication channels. A selection of liked-in communication activities is presented below.

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COOPERATION WITH OTHER PROJECTS

In Case You Missed It: MOBILES Joins Forces to Tackle Pollution.

In our previous issue, we shared that the MOBILES project joined the Marine Shield Cluster—a network of EU-funded projects working together to combat pollution and protect marine and environmental health. This collaboration enhances our mission to develop advanced biosensors for detecting harmful pollutants in water, air, and soil, and to understand how pollution impacts microbiota in European ecosystems. Our inclusion in the Marine Shield Cluster provides an opportunity to align our efforts with other 10 pioneering projects. To learn more about the Marine Shield Cluster and the projects united under its mission, visit cluster's website https://marineshield.eu/

MOBILES, AquaBiosens and BIOSENSEI partnership

MOBILES is also actively engaging with its sister projects, AquaBioSens and BIOSENSEI, funded under the same Horizon Europe call. These partnerships foster knowledge exchange and joint activities, including shared meetings and research visits, with the goal of producing stronger policy recommendations and improving environmental monitoring technologies.

AquaBioSens (ID: 101135432, https://www.aquabiosens.eu)
BIOSENSEI (ID: 101135241, https://www.biosensei.eu)

Concerning cooperative activities with the cluster and other EU-funded projects, the NTUA coordinator team released a public deliverable describing collaboration plans that will be exploited during the next 2-3 years.

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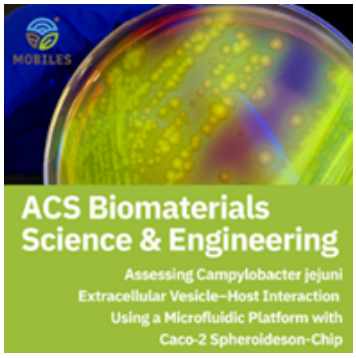
ARTICLES



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PROJECT OVERVIEW

- **Duration:** 1.9.2024 – 29.2.2028
- **Budget:** €4.6 million
- **DOI:** https://doi.org/10.3030/101135402

COMMUNICATION

- **Website:** www.mobiles-project.eu
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- Join us on our mission to revolutionize environmental monitoring and create a sustainable future!

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PROJECT CONSORTIUM

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