MOBILES

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

Press Release

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Summary:

- The National Technical University of Athens (NTUA) is working with another 15 partners from academia, research, and industry to develop prototypes of electronic and organism-based biosensors to monitor organic chemicals, antimicrobial-resistant (AMR) bacteria, and pathogens in water, soil, and air.
- The EU MOBILES project will develop prototypes of portable electrochemical biosensors validated for air, soil, or water quality control for detecting pesticides, hormones, pathogens, and AMR bacteria.
- The MOBILES project will study and develop biosensors for detecting heavy metals, antibiotics, pesticides, arsenic, microplastics, and nanoplastics. It will include genetically modified plants and bacteria for detecting heavy metals, antibiotics, and pesticides, and the use of marine diatoms for monitoring bioplastic degradation.
- The consortium will analyse microbiota in polluted areas to reveal gene clusters and genetic diversity. This will help assess microbial functions and provide genetic markers to quickly evaluate soil and land health.
- Focus: Biological sciences, chemical sciences, soil health, electrochemical biosensors, plants, bacteria, environmental risk, meta-analysis, DNA/RNA sequencing, genetic modification, CECs, PMCs, antimicrobial resistance.

Modern lifestyles and industrial practices generate large amounts of waste and pollutants. Chemicals, including persistent and mobile pollutants (PMCs) and contaminants of emerging concern (CECs), degrade the environment. Another severe global health risk is associated with increasing antimicrobial resistance (AMR) in bacteria. Foodborne pathogens, including *Listeria*, *Salmonella*, and *Campylobacter*, pose significant public health risks and are already monitored. However, current bacterial detection methods for environmental control are slow and require specialized laboratories with trained personnel. Similarly, conventional pollutant detection methods, such as chromatography and mass spectrometry, are accurate but time-consuming and require

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specialized equipment. State-of-the-art detection methods are unsuitable for constant on-site and real-time monitoring. The long time between sampling and detection reduces the efficiency of public health and environmental protection authorities in implementing effective countermeasures.

To tackle this problem, several **electrochemical biosensors** will be developed within the MOBILES project. Biosensors are devices that combine biological elements with electronic systems to detect specific pollutants. The MOBILES project enhances these sensors with advanced nanomaterials, significantly improving their sensitivity and reliability. All biosensors will have common basic electronics and functional principles (e.g., an organic ligand able to recognize target pollutants), but they will differ in the biological element employed: (i) aptasensors based on aptamers that recognize bacterial cells or spore surfaces, (ii) electronic noses for detecting and quantifying volatile organic compounds (VOCs) produced by bacteria, (iii) genosensors for detecting genes involved in antibiotic resistance, and (iv) interdigital capacitors functionalized with aptamers for estradiol, a member of CECs family.

Continual threats (such as industrial pollution and the overuse of drugs and pesticides) to sources of drinking water require real-time solutions for wide-ranging water monitoring systems to detect toxicants such as **heavy metals, pesticides, and antibiotics**. Conventional methods are limited in their ability to detect sub-lethal concentrations of active antibacterial compounds. The damage caused by the activity of an antibacterial agent or pesticide may stimulate different biological mechanisms of bacterial repair. Each antibiotic and/or pesticide triggers specific cellular pathways, mechanisms, and targets within the bacterial cell. This specific biological response, enabling the detection of antibiotics and pesticides using microorganisms, is being investigated in the MOBILES project through the use of **genetically modified bacteria** to detect toxic pollutants in water. For detecting heavy metals (cadmium, chromium, lead, mercury) in water, MOBILES will develop a flow-through device for continuous monitoring using biological systems (genetically modified bacteria) combined with an optical sensor and flow unit.

Different pathways will be used to monitor other pollutants. Highly toxic **arsenic pollution** can come from various sources, including industrial activities, mining, and even natural processes. Water and food contaminated by arsenic can cause serious health problems, including cancer and heart disease. For detecting arsenic pollution in soil and groundwater, the MOBILES project will develop **genetically modified plants** that change colour when arsenic is present in the soil or water used to grow them.

Microplastic and nanoplastic pollution is raising concerns about its potential impact on human health. The transfer of very small plastics through the trophic chain is a potential source of contamination at all trophic levels. Understanding the distribution, degradation, and life cycle of micro- and nanoplastics in the marine environment is limited by the intrinsic difficulties of current techniques for detecting, quantifying, and chemically identifying small particles in liquids. The MOBILES project is addressing this challenge by utilizing **marine diatoms**—microscopic algae that play a crucial role in marine ecosystems. Diatoms are known for their resilience and adaptability,

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making them ideal candidates for studying the biodegradation of bioplastics in marine environments. Preliminary studies have shown promising results, indicating that diatoms not only survive in environments containing bioplastics but also contribute to their biodegradation.

In addition to the development of sensors, MOBILES will undertake comprehensive **metagenomic analysis**, profiling the microbiota of polluted areas across Europe. This work will uncover gene clusters and reveal genetic diversity, enabling a deeper understanding of microbial functions. These insights will provide genetic markers to facilitate rapid evaluation of soil and land health. Two annual sampling rounds are planned for at least two years, and sample collection will be conducted at **different locations to target microbiota related to specific pollution types**: Greece for urban wastewater contamination, Poland for heavy metal pollution, Cyprus for microplastics and plastics, France for agriculture and animal farming, Italy for arsenic, and Germany for chemicals and heavy metals from former mining activities. Genomic and transcriptomic data will be analysed, visualized, and interpreted using bioinformatic tools and soil metagenomic web-based platform specifically realized by MOBILES partners. The project's data storage, located in Spain, will be connected to other well-known genomic databases in order to provide a wide range of information.

The biosensors will be rigorously tested with real-world samples from polluted sites to validate their environmental performance. Furthermore, the project will conduct **safety evaluations** to ensure that the **genetically modified organisms** and developed devices have minimal environmental impact.

MOBILES leverages cutting-edge biotechnology to enhance the accuracy and efficiency of detecting biotic and abiotic pollutants while addressing current shortcomings by employing advanced nanomaterials, genetically modified bacteria and plants, and natural elements. Another significant innovation of the project is the creation of a soil metagenomic database, which will map pollutant-linked genes and serve as a resource for environmental research and diagnostics.

The MOBILES project is funded by the European Union (Project: 101135402, call HORIZON-CL6-2023-ZEROPOLLUTION-01). The project is coordinated by the **National Technical University of Athens** and runs from September 1, 2024, to February 29, 2028.

For more information, visit www.mobiles-project.eu and project's profile on LinkedIn and X.

Consortium

National Technical University of Athens (GR) | The National Research Council (IT) | National Research Institute for Agriculture, Food and Environment (FR) | Sapienza University of Rome (IT) | EDEN TECH (FR) | Public University of Navarre (ES) | The Institute of Soil Science and Plant Cultivation (PL) | The Agricultural Research Organisation of Israel - The Volcani Centre (IL) | University of Bordeaux (FR) | Cyprus University of Technology (GR) | University of Belgrade (RS) | MAT4NRG (DE) | Clausthal University of Technology (DE) | GRANT Garant (CZ) | Research and Innovation Centre Pro-Akademia (PL)