The continuously increasing number of passenger and commercial vehicles contributes to the intensifying emission of tire wear particles (TWPs), which originate mainly from tires but also from other rubber car components. Although these tiny, barely visible particles may seem harmless, they pose a significant threat as they accumulate in the environment over a long period, eventually reaching dangerous concentrations. The main environmental threat associated with TWPs lies in the chemical compounds released from these particles, including hydrocarbons and components of rubber blends such as carbon black, curing agents, plasticizers, and heavy metals. Factors that significantly increase the emission of rubber particles include greater vehicle mass (especially in electric cars) and the use of all-season tires, which wear out more quickly under summer conditions.

Because busy roads and airports are often located in close vicinity to agricultural fields, rubber particles released into the environment may affect both the quantity and quality of crops by directly disturbing plant growth and indirectly by negatively impacting soil microorganisms. These microorganisms play a crucial role in plant health and crop productivity. Some plants can also absorb contaminants and accumulate them in their tissues, posing a risk to animals and humans who consume them.

Other places where fresh rubber scraps or used tires are used include sports facilities and playgrounds equipped with soft, shock-absorbing surfaces. These surfaces, when exposed to weather conditions and friction caused by use, may release rubber particles, posing a direct threat to users as well as to the surrounding environment, including soil and plants.

The main objective of this project is to assess the impact of different concentrations of rubber particles, and particularly the pollutants released from them, on organisms belonging to various levels of the food chain. Soil, plant, and air samples will be collected from agricultural fields at different distances from pollution sources. A similar approach will be applied to the study of playground surroundings. Control samples will be collected from locations free from TWP contamination. We will investigate the effects of these pollutants on soil microorganisms, crop plants, and selected human cell lines to comprehensively evaluate the consequences of exposure to rubber pollution in the environment. Our goal is to perform a thorough risk analysis related to the environmental release of rubber particles. To achieve this, we will use the latest chromatographic, microscopic, spectroscopic, and molecular techniques, including DNA and RNA sequencing from soil and plant samples.

Another objective of this project is to evaluate the effectiveness of biological methods for cleaning soil contaminated with rubber particles. For this purpose, we will use microorganisms isolated during the project that can degrade organic compounds, as well as plants capable of absorbing heavy metals and accumulating them in their tissues. This alliance of plants and microorganisms is known as assisted phytoremediation. Our team’s previous research has shown that such systems can effectively clean contaminated soil, and the plants that accumulate pollutants can be safely disposed of through incineration. Importantly, the presence of plants, especially their extensive root systems, creates a favorable environment for microorganisms capable of degrading organic pollutants released from rubber particles.

In summary, our goal is a comprehensive diagnosis of a growing environmental issue that threatens us directly when we are present in contaminated areas and indirectly when we consume food exposed to pollution. We will also verify the usefulness of environmentally friendly, natural biological methods for removing pollutants released from rubber particles. This type of comprehensive approach has not yet been described in scientific literature, which is a major advantage of this project and highlights its innovative nature. The research will be conducted by experienced specialists in microbiology, chemistry, biotechnology, and molecular biology.