



Pollutants are never still: Why *Pollutants Dynamics*?

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Rachel Carson's classic book *Silent Spring*, published more than six decades ago, profoundly awakened the public to the hidden costs of synthetic chemicals. Since then, societies have banned dichlorodiphenyltrichloroethane (DDT), phased out leaded petrol, removed polychlorinated biphenyls (PCBs) from commerce, and restored many watersheds once considered lost. These are genuine achievements, demonstrating that pollution science, when coupled with effective policy, can work. Yet pollution has not disappeared; instead, it has changed shape. Countless chemicals and mixtures are now registered for production and use worldwide. Chemical production has accelerated over decades and may increase several-fold over the next two decades. Persson *et al.*^[1] suggested that humanity had already moved beyond the "safe operating space" of the Earth boundary, as the rate at which new substances are produced and released outstrips our collective capacity for assessment and monitoring. The widely cited Lancet Commission on pollution and health estimated that pollution was responsible for approximately nine million premature deaths in 2019, and that mortality attributable to "modern" pollution, including ambient air pollution and toxic chemicals, had risen by more than 66% since 2000^[2].

It is clear that pollution is not a problem that can be solved once and then archived. Every generation of technology brings its own generation of pollutants. I often remark to my students that environmental scientists perform "downstream" work: we follow and study problems generated by technological development. Legacy pollutants such as mercury, cadmium, and persistent organochlorines continue to cycle through soils, sediments, and food webs. Meanwhile, a growing list of emerging pollutants, e.g., per- and polyfluoroalkyl substances (PFAS), microplastics and nanoplastics, pharmaceuticals and personal care products, engineered nanomaterials, flame retardants, tire-wear particles, and countless transformation products, to name only a few, are appearing faster than regulatory science can evaluate them. Climate change further reshapes this picture by remobilizing contaminants from previously sequestered reservoirs and altering the temperature-dependent kinetics of uptake, metabolism, and toxicity. Pollution is therefore a never-ending story, and the science devoted to understanding it must be equally continuous and adaptive.



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The name of this journal has been carefully chosen. For decades, pollution research was dominated by static descriptors: total concentrations in a matrix, a single median lethal concentration, or a fixed partition coefficient. Equilibrium was a common term in the field when I was a graduate student 30 years ago. These metrics were invaluable for identifying existing problems, but they are far less adequate for explaining why a contaminant harms one species but not another, how a substance travels from a factory outfall to a human placenta, or when low-level chronic exposure crosses the threshold into an adverse outcome. Pollutants are, by their very nature, in constant flux. They are released, transported across phases and compartments, speciated and transformed by light, microbes, and redox conditions, taken up across biological membranes, distributed among organs, metabolized, excreted, and transferred along food chains. Toxic effects themselves unfold over time, as molecular initiating events propagate through cellular and organismal responses to affect populations and ecosystems. Concepts such as biodynamic modeling, toxicokinetic-toxicodynamic (TK-TD) modeling, and the exposome have shown that rates, fluxes, and trajectories, rather than snapshots, ultimately determine pollutant risks. *Pollutants Dynamics* is therefore established with these dynamic, mechanism-driven processes as its central concern, from source to receptor and from molecule to ecosystem.

Perhaps the most compelling reason for establishing a new journal is that pollutant behavior does not respect disciplinary boundaries. Understanding the fate of a single PFAS compound in a watershed requires analytical chemistry to detect it, hydrology and geochemistry to track its transport, microbiology to describe its transformation, physiology to explain its uptake and protein binding, toxicology to characterize its effects, epidemiology to connect exposure with human outcomes, and, increasingly, data science to integrate the whole. Microplastics present an even more explicitly interdisciplinary challenge: they are simultaneously particles, polymers, vectors for sorbed chemicals and additives, substrates for microbial biofilms, and physical stressors in an organism's gut. No single field owns this problem. Too often, however, these threads are published in separate venues. A chemist may report a transformation product that a toxicologist never tests; a modeler may parameterize uptake using values that an experimentalist considers invalid; an ecologist may document a population decline whose mechanistic cause lies hidden in an omics dataset published elsewhere. *Pollutants Dynamics* is designed as a meeting place for these communities. We explicitly invite work bridging environmental science, toxicology, environmental health, ecology, chemistry, engineering, and data science, and we will give particular weight to studies connecting at least two links in the chain from source to exposure, biological fate, and risk.

Our seven thematic areas deliberately map this chain. We welcome research on pollutant sources, transport, and transformation, including emissions, multiphase transport, speciation, degradation, and persistence. We seek advances in bioavailability and exposure science, recognizing that the concentration in an environmental medium is only a distant proxy for the dose that actually reaches a biological target. We encourage studies of bioaccumulation, biodynamics, and trophic transfer, ranging from subcellular partitioning and organ-specific accumulation to biomagnification across entire food webs. We invite research on toxicodynamics and mechanistic toxicology, including omics-based approaches, oxidative stress, immunotoxicity, and the development and validation of adverse outcome pathways. The journal will devote sustained attention to emerging contaminants such as microplastics and nanoplastics, PFAS, pharmaceuticals and personal care products (PPCPs), N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine quinone (6PPD-Quinone), engineered nanomaterials, and novel transformation products, while remaining equally open to new insights into legacy pollutants (e.g., metals, pesticides), whose dynamics are far from fully understood. We provide a dedicated home for environmental artificial intelligence and predictive toxicology, and we situate all these areas within the broader framework of environmental health and ecosystem risk, including One Health and planetary health perspectives that recognize the inseparability of human, animal, and ecosystem well-being.

The present moment is also marked by a technological transition. High-resolution mass spectrometry can now reveal thousands of features in a single sample, most of which remain unidentified. Non-target screening, high-throughput *in vitro* assays, single-cell and spatial omics, environmental DNA, and sensor networks generate data at scales unimaginable just a decade ago. Machine learning and, increasingly, foundation models offer ways to transform these data into predictions of persistence, bioaccumulation, toxicity, and exposure for substances that may never be tested individually. We are now entering an exciting era of technological innovation, opening new possibilities for unraveling the dynamics of pollutants.

We are enthusiastic about these developments, but not uncritical. Predictive models are only as reliable as the mechanistic understanding and data on which they are built; black-box predictions that cannot be reconciled with chemistry and biology have limited regulatory or scientific value. *Pollutants Dynamics* will therefore favor studies in which computational and experimental approaches inform one another: models that generate testable hypotheses and experiments designed to constrain and refine models. We also encourage transparent reporting, open data, and shared code so that predictive tools can be independently evaluated and continuously improved by the community.

Mechanistic science matters because it provides the foundation for sound management. The failure of negotiators to conclude a global plastics treaty in Geneva in August 2025 reminds us how contested such action remains and how much depends on the clarity and credibility of the underlying evidence. Journals have a responsibility to publish rigorous work, communicate uncertainty, and make scientific findings accessible. As a fully open-access journal, *Pollutants Dynamics* is committed to ensuring that knowledge about pollutants is available to the researchers, regulators, and communities who need it and wherever they are.

Pollutants Dynamics publishes Research Articles, Reviews, Perspectives, Communications, Comments, Editorials, and Research Highlights. We welcome submissions on Perspectives that challenge prevailing paradigms, Technical Reviews that consolidate methods across disciplines, and Communications that rapidly report unexpected findings. We are committed to constructive, timely, and expert peer review and to building an editorial board that reflects the geographic and disciplinary diversity of our field.

Pollution will not end within our lifetimes. Each new material, each new molecule, and each shift in climate or land use will create new dynamics to understand. Our ambition is to build an enduring, interdisciplinary knowledge base that enables societies to anticipate problems rather than merely react to them.

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The author contributed solely to the article.

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Not applicable.

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