IWRA

International Water Resources Association

POLICY BRIEF
Number 25
July 2023

UNESCO-IWRA ONLINE CONFERENCE
IN THE IWRA ONLINE CONFERENCE SERIES

EMERGING POLLUTANTS: PROTECTING WATER QUALITY FOR THE HEALTH OF PEOPLE AND THE ENVIRONMENT

THEME II

Emerging pollutants and groundwater

KEY POLICY MESSAGES

- In principle, preventing groundwater contamination is less expensive than remediation, but our ability to monitor contamination is limited.
- Risk assessment tools are available to assist decision-makers in prioritizing emerging substance contamination of groundwater and to improve groundwater quality monitoring programs.
- PFAS (per- and polyfluoroalkyl substances) are of priority concern, as they are likely the most harmful to human health.
- Governments should require manufacturers to disclose the use of contaminants of concern in consumer products as part of a strategy to increase public awareness.

Groundwater provides almost half of all drinking water sources worldwide and about forty percent of the water used in irrigation (UNESCO, 2023). This underground resource is essential for health and food security in communities around the world, yet monitoring of groundwater quality can be expensive and often requires specialized equipment, knowledge, and skills.

EMERGING POLLUTANTS AND GROUNDWATER

Groundwater protection is much more cost effective than groundwater remediation after contamination. But contamination of groundwater can go undetected due to flows from an unknown contamination source (such as an underground chemical storage vessel), contamination from surface pollutant sources, or from natural features of the soil or rock (e.g., where arsenic or uranium naturally occur). Emerging pollutants, also known as contaminants of emerging concern (CECs), behave differently in groundwater than in surface water due to slower subsurface transport and consequently higher residence times.

In general, another reason that less is known about CECs in groundwater is a perception that groundwater is at lower risk of contamination. A conceptual understanding, and subsequent prioritization, of CECs in groundwater requires knowledge of the mobility of CECs in groundwater environments, environmental exposure, toxicity, and relative risks posed to groundwater. Regular monitoring and analytical testing are needed to improve the evidence base to inform policy for groundwater protection and, where available, existing monitoring data can be a basis for prioritization. Additional information is needed on contaminant source areas, concentration trends (e.g., the characteristics of a plume of contaminant in groundwater as it migrates from a pollution source), and degradation products as CECs transform into other compounds of concern . As in other water supplies, work to identify and address priority contaminants in groundwater is needed.

A three-phase procedure can be used to understand emerging pollutants of concern in groundwater: (1) develop a conceptual understanding and approach; (2) prioritize emerging contaminants; (3) monitoring and evaluation studies. More fundamentally, for management of CECs, there is an urgent need for a coherent and robust approach to protect groundwater from CEC contamination, including the enactment of stronger policies and changes in how society views and uses the chemicals.

Some regional initiatives are in place to improve the monitoring of priority CECs. For example, the European Groundwater Watch List is a voluntary process intended

Contamination of groundwater can go undetected.

to produce high-quality Europe-wide monitoring data on substances that have not been routinely monitored and that may pose a risk to groundwater bodies.

CONTAMINANTS OF GREATEST CONCERN

Six categories of CECs have been identified in the literature on groundwater quality: (1) pharmaceuticals, (2) personal care and household cleaning products, (3) industrial chemicals, (4) flame retardants (which contain PFAS), (5) cyanotoxins, and (6) nanomaterials. The literature identifies PFAS to have the highest certainty of causing human health problems. Research also indicates that more sustained monitoring in groundwater should be directed at certain toxic pharmaceuticals and common toxic compounds in cosmetics and personal care products.

RISK ASSESSMENT AND PRIORITIZATION OF CECS IN GROUNDWATER; TOOLS IN DEVELOPMENT

Risk assessment is a coherent, science-based decision-making process that also communicates chemical pollutant risk. Risk assessments contribute to governance processes for priority-setting for potential future scenarios of chemical exposure and environmental and human health analyses. Tools have been developed to carry out this kind of risk assessment. For example, Risk Assessment in the 21st Century (RISK21) provides a framework that can be applied for screening and prioritizing chemicals to assess which chemicals warrant further assessment or additional data collection. The framework informs the organization of all relevant information for an interactive and transparent evaluation of the available exposure and hazard information.

Analytical tools have also been developed based on Geographic Information System (GIS) technology to assess the location and source areas of PFAS contamination. GIS tools have also been applied to improve or optimize monitoring of CECs.

ACTIONS IN PROGRESS AND NEXT STEPS

The European Commission is finalizing legislation to eliminate the widespread release of PFAS compounds in biosolids produced during biological wastewater treatment that are then used as soil amendments for agricultural areas. The

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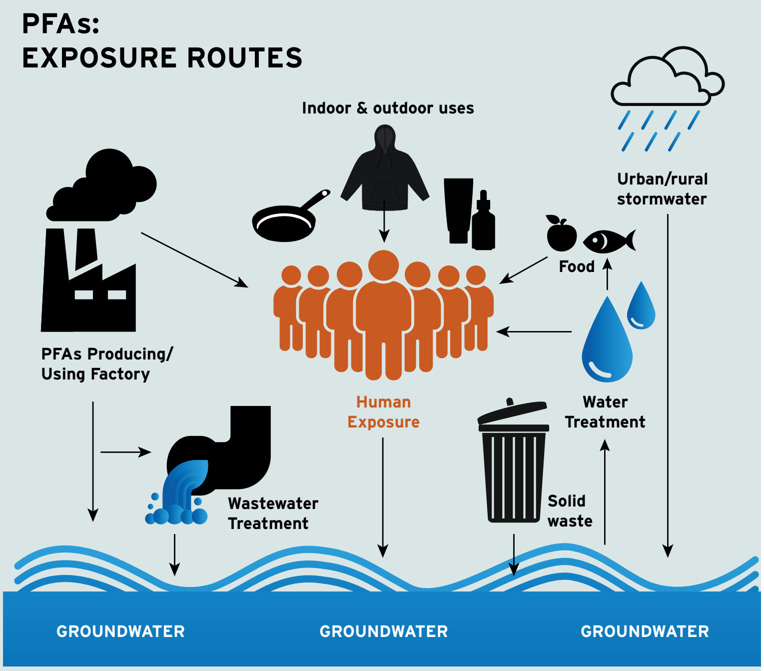
CONSUMER PRODUCTS OF EMERGING CONCERN

Examples of PFAS-bearing consumer products include non-stick coatings (e.g., Teflon), textiles (e.g., Gore-Tex), stain-resistant carpets and furniture, and aqueous firefighting foams. Other consumer products with CECs include cosmetics, deodorants, cleansers (soap, shampoo, toothpaste), moisturizers, perfumes, sunscreens, hair styling products, and shaving creams. Industrial chemicals with CECs include pesticides, 1,4-Diozane (a chemical used in pharmaceutical and plastic production), and explosives. Nanoparticles are used in hundreds of consumer and biomedical applications, using carbon fiber, aluminum, or silver, among other materials, for antibacterial properties, optical displays, anti-static properties, wrinkle resistance, UV blocking and more. Pharmaceuticals, including antibiotics, anti-inflammatories, pain relievers, lipid regulators, antidiabetics, and others, are in common use but are rarely monitored in groundwater, and concentrations in groundwater with potential health effects have not been established.



PFAS compounds continue to leach into underlying groundwater from biosolids soil amendments. Researchers have recommended that other countries follow the lead of the European Commission to manage the use of biosolids on agricultural soils.

Legislation needs the support of the public for full and effective implementation.

Therefore, public awareness of CECs in common products is part of a comprehensive approach to source controls and reduction of exposure to these chemicals. Researchers have also called on governments to require manufacturers to disclose the use of CECs in products.

EMERGING CONTAMINANTS FOUND IN GROUNDWATER AROUND THE WORLD INCLUDE:

- organic contaminants from sunscreens and antibiotics in the groundwater of the Yucatán peninsula as proxies to estimate human presence and related reduced water quality in recreational areas of Mexico;
- organic contaminants in the groundwaters and recharge sources in Bengaluru City, Karnataka, India, including the ubiquitous detection of sweeteners, which indicates groundwater age since their compounds were introduced only relatively recently; and
- a variety of microplastics in urban soil and groundwater in Bauru, São Paulo, Brazil, which impact biota and pose a risk to human health but are not well-studied in groundwater.
- Antimicrobial resistance (AMR) in karst groundwater supplies in the Tampa Bay region of the United States where AMR was found to be disseminated throughout urban karst aquifers, replicating the results of a similar study in Kentucky, USA .

SOURCES:

Groundwater statistic from UNESCO: UNESCO hosts first UN-Water Summit on Groundwater
www.unesco.org/en/articles/unesco-hosts-first-un-water-summit-groundwater

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UNESCO/IWRa Online conference
17-19 January 2023
Proceedings (abstracts, presentations and posters).

ACKNOWLEDGEMENTS

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