Research needs for emerging contaminants

Detlef Knappe
knappe@ncsu.edu
What do we know about chemicals that surround us?

How do emerging contaminants enter the aquatic environment?

Gerbersdorff et al., Env. Int. 79: 85-105 (2015)
Challenges associated with assessing risk associated with emerging contaminants

In recent years, much progress has been made in the assessment of micropollutants in aquatic systems. Quantification and explicit communication of irreducible uncertainties therefore need to be an integral part of exposure and effect assessment. To date, it has been common practice, in particular in European legislation, to divide the manufacturing practices accordingly. This will not only mitigate strategies, and for adapting manufacturing processes. The assessment of whether or not a new and existing chemicals, for designing consumption.

Environmental Engineering and Science

- Characterize physical-chemical properties and (bio)transformation potential of emerging contaminants
- Develop treatment technologies for emerging contaminants
  - Polar compounds (e.g. 1,4-dioxane)
  - Persistent organic pollutants (e.g. organofluorine compounds, flame retardants)
- Develop management strategies for treatment residuals
  - Recover nutrients, energy
  - Remove emerging contaminants from residuals
- Develop best management practices for non-point sources (e.g. fire fighting training sites, agricultural runoff, urban stormwater)
- Environmental fate and transport models
  - Surface water
  - Sediments
  - Subsurface
Analytical chemistry

• Challenges
  – Occurrence at ppb to ppt levels
  – Time-consuming sample preconcentration is required prior to analysis with expensive equipment
  – Low temporal and spatial resolution of occurrence data
  – Non-targeted analysis (finding/identifying unknown unknowns)

• Research Needs:
  – Develop rapid analytical methods
  – Expand mass spectral libraries for emerging contaminants
  – Increase temporal and spatial resolution of occurrence data by identifying indicator compounds that can be analyzed with relative ease
  – Develop international sampling protocols and analytical methods
Biological monitoring

• Challenges
  – Detect presence of emerging contaminants at levels below those that can be detected by analytical chemistry methods
  – Identify effects associated with chronic (rather than acute) exposure
  – Assess the effects of contaminant mixtures

• Research needs
  – Online biomonitoring: What organisms should be selected to answer human-health related questions
  – Biomarkers: Diversity of toxicological endpoints, chronic/acute effects, mixtures (additive, synergistic, antagonistic effects)
  – Complementary techniques: Passive samplers (selectively capture contaminants with different characteristics) followed by bioanalytical assays to identify chemical stressors for different contaminant fractions
  – Human exposome: To what extent do contaminants in the aquatic environment contribute to our overall body burden?
Environmental Policy

Challenges:
• Most regulations associated with chemical pollutants were developed in the 1970s-1980s
• The list of compounds that may need to be regulated keeps expanding

Research needs:
• Instead of continuing to expand the list of regulated contaminants, would the specification of treatment techniques be sufficiently protective (e.g. all drinking water treatment plants must include a granular activated carbon filter)
• Are there unintended consequences if advanced treatment processes are required for all drinking water and wastewater treatment plants (e.g. increased carbon footprint, increased air pollution resulting from increased energy demand)