PROMISCES

Risk-based human exposure assessment of chemicals in the circular economy

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IWA the international water association

BACKGROUND

The situation

Water reuse is becoming increasingly important. How can we ensure safe use of water, given the large number of potentially harmful substances and the many different forms of exposure?

PROMISCES

PROMISCES addresses the assessment, transport and fate of PFAS and further industrial, persistent, mobile and toxic (iPMT) substances in the water cycle, and developed a human health exposure assessment (HHEA).

Human Health Exposure Assessment (HHEA)

1. Knowledge gaps on emerging contaminants (risk-based) are dealt with *intuitively*
2. Steady state assessment done *probabilistically*
3. Literature and sample data can be integrated *iteratively* (Bayesian updating)
4. Exposure routes can be built *flexibly*
5. Scenarios can be compared to identify important treatments or most critical substances *easily*

Integrated processes

- Primary, secondary, different tertiary wastewater treatments technologies
- Conventional and advanced drinking water treatments
- Mixture processes, such as dilution or concentration via different water types
- Nature based processes, such as constructed wetlands and riverbank filtration
- Groundwater remediation processes

Method - Removal factor distribution using activated carbon (GAC) treatment

Probabilistic removal factor approach

The final concentration is a result of successively applied removal factors of all processes in an exposure route

Default removal factor distribution

U-shaped symmetrical Beta distribution

! without any additional data, a treatment process is skewed towards a best-case/worst-case assessment

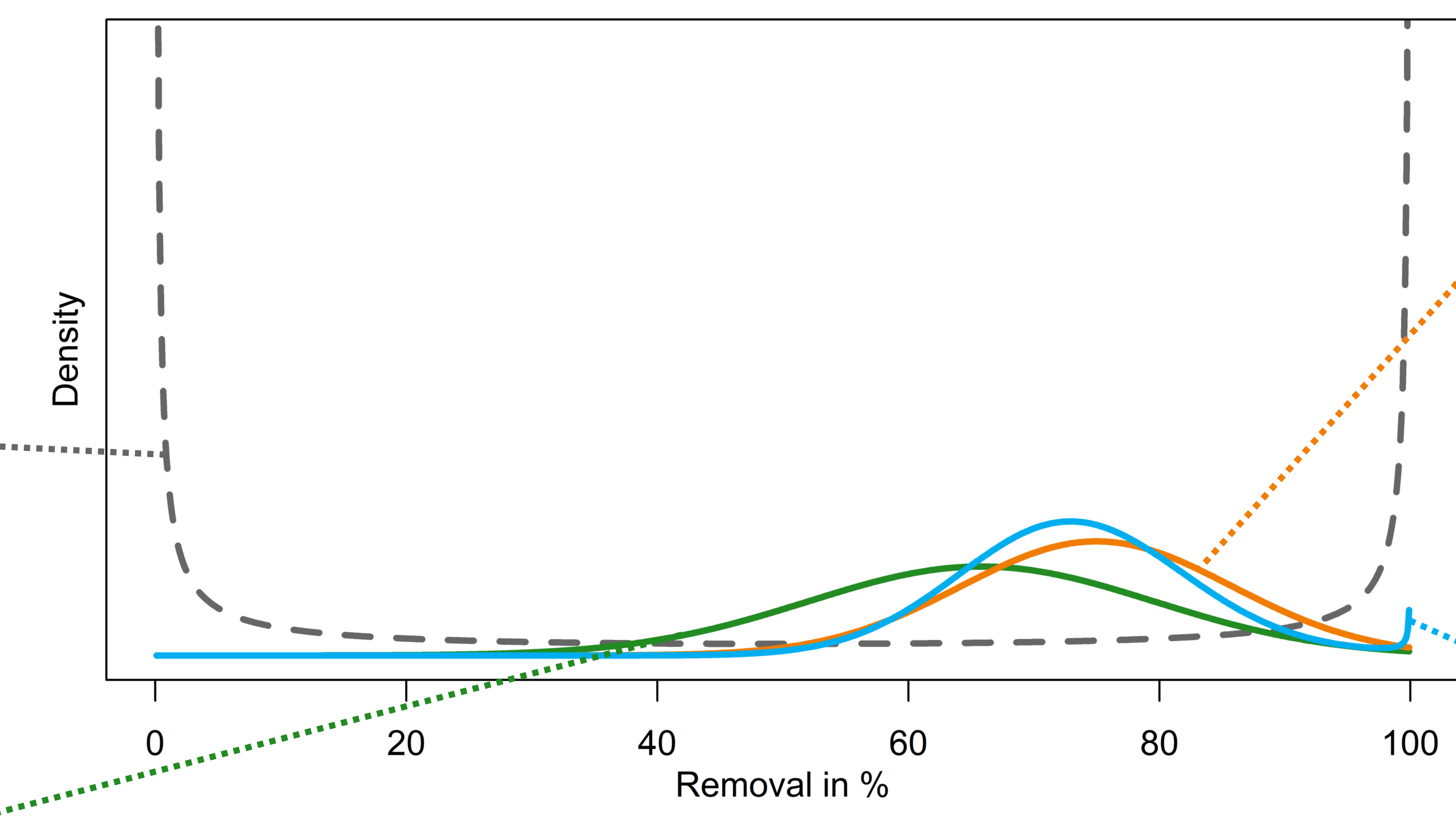


Figure 1: Probability distributions of the Bayesian updating process

Likelihood distribution based on literature and/or model data

Each study is included as one mean value per process setting

! Equal weights for different process settings regardless of the number of measurements per setting

4 studies with different GAC bed volumes included: 90% (Belkouteb et al., 2020) **76% and 56%** (McCleaf et al., 2017), **49% and 68%** (Franke et al., 2021) **and 64% removal** (Chularueangaksorn et al., 2014)

Likelihood distribution based on on-site data

Each measurement counts

3 hypothetical measurements in the example: 75%, 80%, 85% removal

Likelihood starting point

Added a 0% removal data point to build a normal distribution

! Higher removal factors require more confirmation data

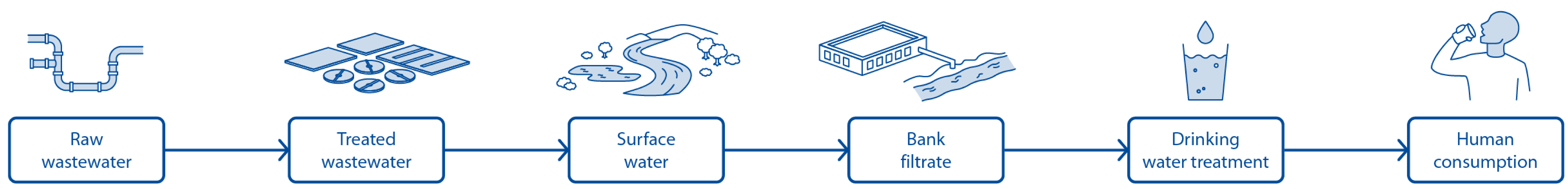
Posterior removal factor distribution

Default and both likelihood distributions are discretized (i in 0.1% steps) and multiplied

$$p_{post,i} = p_{def,i} \times p_{lit,i} \times p_{sample,i}$$

Finally the distribution is rescaled

PFOS in the semi-closed water cycle



Four different scenarios simulated

No.	River size	River background	GAC on-site measurements
1	Small	clean	No
2	Small	clean	Yes
3	Large	clean	Yes
4	Small	contaminated	Yes

Outcome

- High impact of on-site GAC removal measurements (tailored to local situation)
- Dilution processes and background environmental concentrations very important

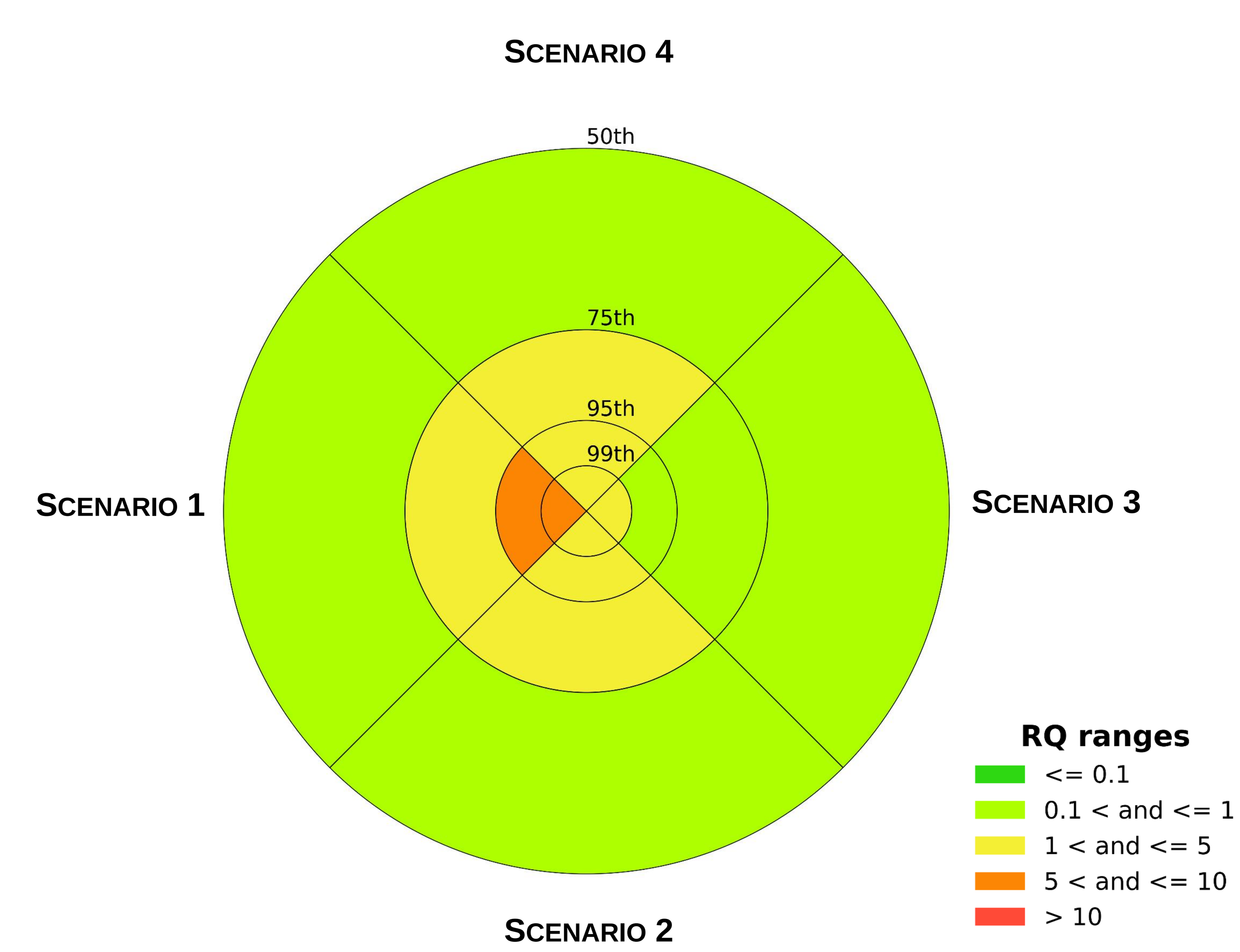


Figure 2: Reference quotient (RQ) of different quantiles of the final concentration for 4 scenarios.

Future work

- PFAS and iPMTs will be assessed in 4 exposure routes
  1. Semi-closed water cycle
  2. Groundwater remediation
  3. Water reuse for agricultural irrigation
  4. Nutrient recovery
- In 2025, the HHEA Tool will be published on Github

Regular updates

Partners

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