Assessment of the usefulness of integrating stable isotope data and pharmaceutical data to disentangle point and diffuse sources of nitrate pollution

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Background

- Nitrate contamination is widely accepted to be a major threat to water quality.
- A wide variety of natural and anthropogenic sources contribute to elevated nitrate levels via point or diffuse inputs.
- Nitrate source determination (NSD) is necessary in the application of the environmental liability directive and the polluter pays principle.
- Various approaches have been adopted for nitrate source determination, including nitrate stable isotopes and genetic markers. However, they each have a number of significant limitations.

Current Limitations

- Standard LC-MS/MS techniques and novel analytical approaches for chemical marker detection at sites of low contamination indicative of diffuse inputs were assessed to meet the current limitation in differentiation.

Chemical Marker Analysis

- LC-MS/MS
  - Destructive
  - Non-destructive
  - Intensive Sample Preparation
  - Minimal sample preparation
  - Large Sample Volumes
  - Low Sample Volumes
  - High Limit of Detection
  - Low Limit of Detection
  - Confirmatory analysis
  - Non-confirmatory/indicative analysis

- NMR
  - Destructive
  - Non-destructive
  - Intensive Sample Preparation
  - Minimal sample preparation
  - Large Sample Volumes
  - Low Sample Volumes
  - High Limit of Detection
  - Low Limit of Detection
  - Confirmatory analysis
  - Non-confirmatory/indicative analysis

- Immunoassays
  - Destructive
  - Non-destructive
  - Intensive Sample Preparation
  - Minimal sample preparation
  - Large Sample Volumes
  - Low Sample Volumes
  - High Limit of Detection
  - Low Limit of Detection
  - Confirmatory analysis
  - Non-confirmatory/indicative analysis

A decision tool was developed using IDEF0 methodologies. It identifies the most suitable approach for achieving NSD within a specific scenario, by bringing together currently fragmented knowledge.

Decision Tool

- Scenario Context
- Site Requirements
- Site Characteristics
- Potential Sources
- Study Scope
- Timeline
- Budget
- Expertise
- State of Approach
- Cost
- Sample Requirements
- Analytical Capability
- Technique Availability

Validated Choice

Differentiation Limitations

- Current methods do not allow for sewage and manure differentiation.
- Chemical markers, such as pharmaceuticals, show high potential for achieving this differentiation [1].

State of Knowledge

- Knowledge on NSD is highly fragmented.
- A decision tool that brings together the fragmented knowledge to identify the most appropriate approach for a particular scenario, is required.

Future Work

- LC-MS/MS method transfer to a new instrumentation due to instrument change.
- Analysis of final monitoring programme samples using the revalidated LC-MS/MS method.
- Studies on the applicability of carbon stable isotopes for achieving source differentiation of sewage and manure inputs.
- Validation of the decision tool for use in environmental forensic studies into nitrate source determination and characterisation through interviews with key stakeholders.
- On the basis of the outcome of the interviews carried out as part of the validation process, the decision tool will be optimised for use.

Publications

4. Attitudes towards the use and disposal of unused medications in two European countries. Submitted.

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