UNESCO-IWRA ONLINE CONFERENCE
17-19 JANUARY 2023
3RD IN THE IWRA ONLINE CONFERENCE SERIES

Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

Multi-tracer approach for understanding emerging pollutants sources and behaviour in aquatic systems to support national and transboundary water management

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Programme hydrologique intergouvernemental

IWRA International Water Resources Association

Introduction

Problem addressed:

Emerging pollutants pose a risk to the quality of drinking water - a key factor of well-being as recognized in the UN Sustainable Development Goals.

New approach:

Combining **emerging pollutants** with **environmental isotopes** to improve the understanding of emerging pollutants sources and behaviour in aquatic ecosystems.

Policy:

Coordinated Research Project "Improving understanding of nitrate sources in the connected river and groundwater systems through linking nitrate isotopes and contaminants of emerging concern" (2022-2025) which includes 14 countries with different environmental and socio-economic conditions.

Best practice guideline on integrating environmental isotopes and emerging pollutants to delineate anthropogenic pollution sources and evaluate pollution-related processes and the water quality.

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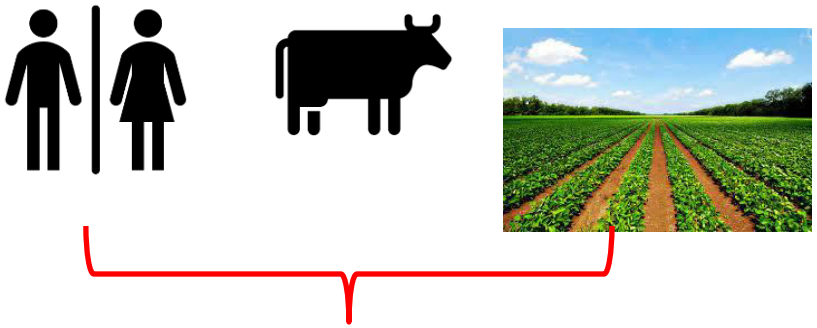
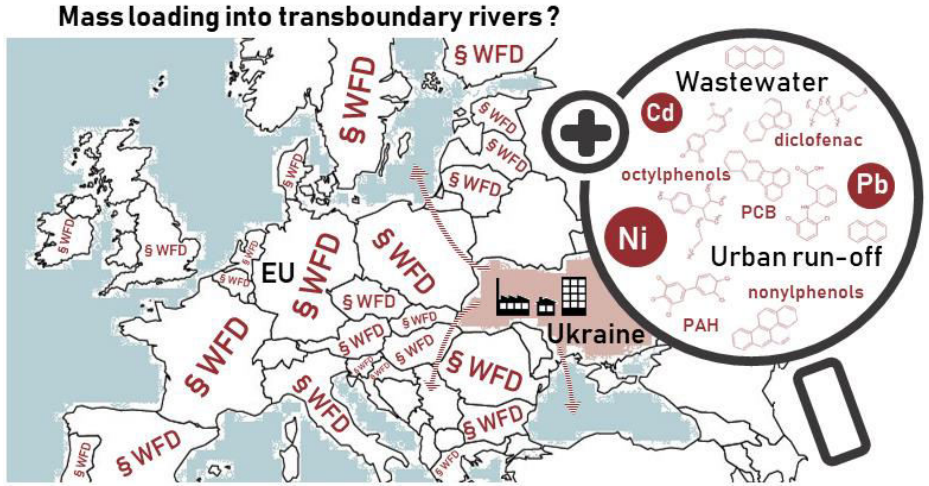
Chemical tracers: Compounds of emerging concern

have been detected in water bodies, they may cause ecological or human health impacts, and typically are not regulated under current environmental laws

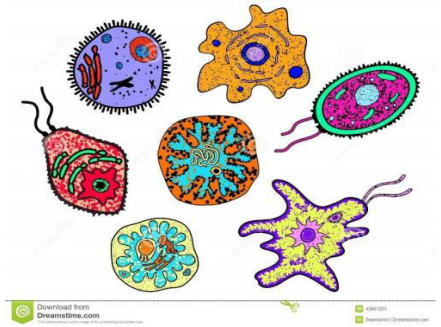
Exact sources and pathways



Participation in hydrological cycle

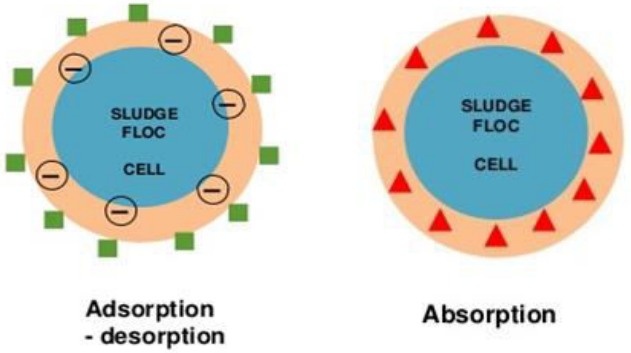


§WFD *means countries where Water Framework Directive is applied*



Behavior and factors controlling it

Uptake by plants and degrade by microbes?
Adsorption/desorption? Absorption?



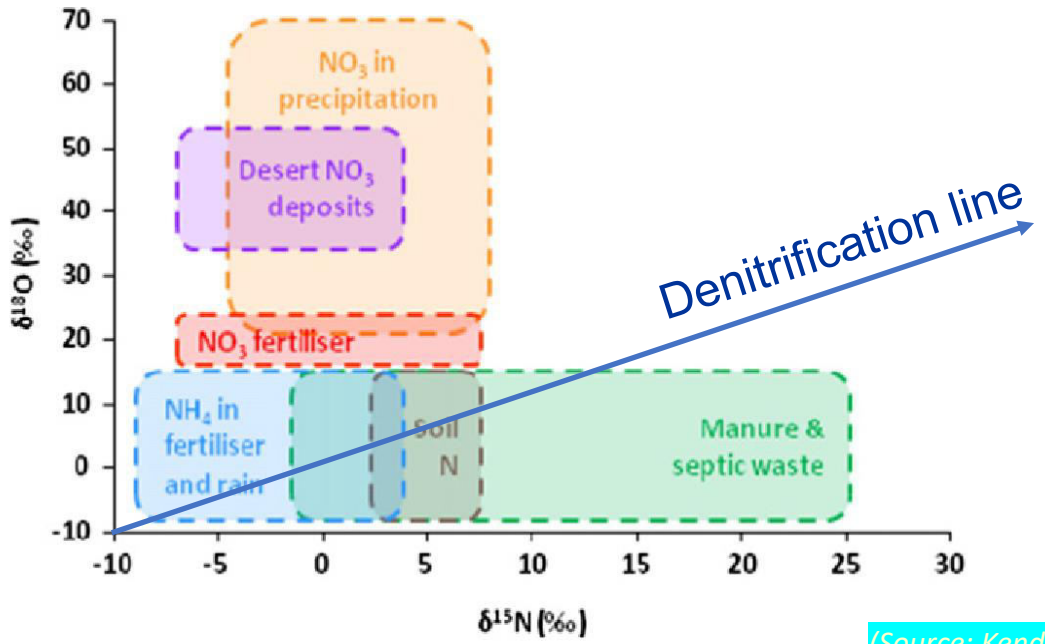
Physical tracers: Environmental isotopes

Stable isotopes are non-radioactive and non-disruptive TRACERS & INTEGRATORS

Isotopes = Nuclides of single element having different atomic weights (Soddy 1914)

Element	Isotope	Abundance
Hydrogen	^{1}H	99.985
	^{2}H	0.015
Carbon	^{12}C	98.89
	^{13}C	1.11
Nitrogen	^{14}N	99.63
	^{15}N	0.37
Oxygen	^{16}O	99.759
	^{17}O	0.037
	^{18}O	0.204

Stable isotopes in nitrate (NO_3)



(Source: Kendall, 2008)

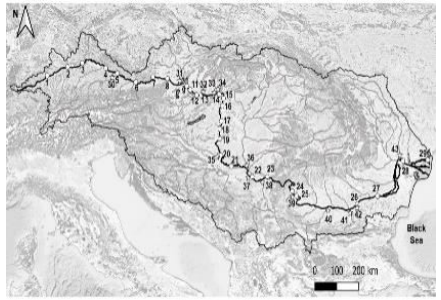
Nitrogen source identification

Identification of flow paths and interactions between water bodies

Identification of biogeochemical processes that alter nitrogen compounds and other chemicals

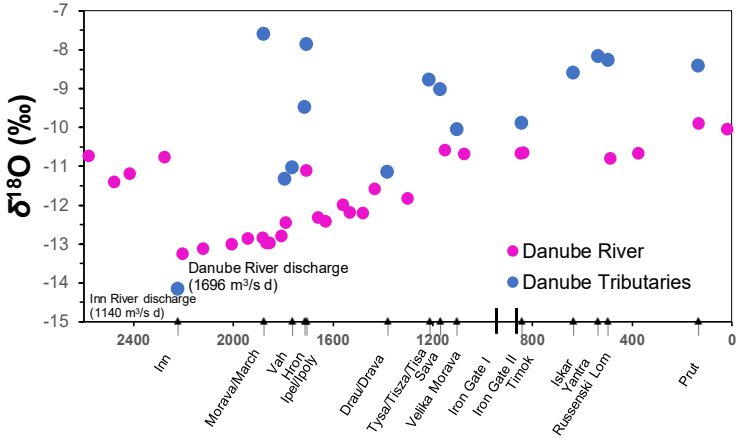
Assessment of the capacity for self remediation by denitrification

CECs + isotopes in Danube traced low biological activity and snowmelt controls on nitrate derived from groundwater



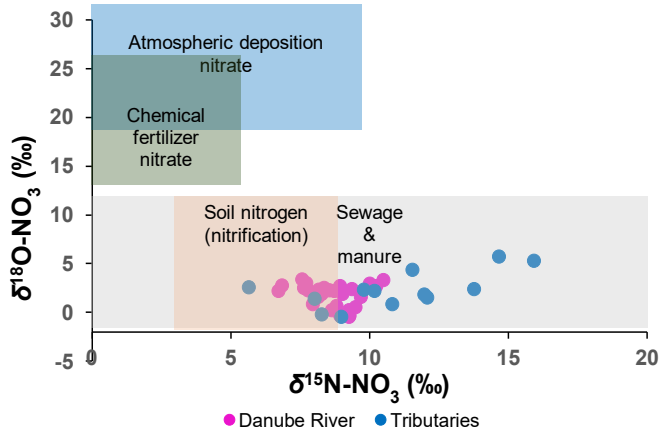
Danube basin

- Mixing of pollution sources
- Slower integrated responses in large rivers



Water isotopes

Snowmelt from Inn River impacts up to 1000 km

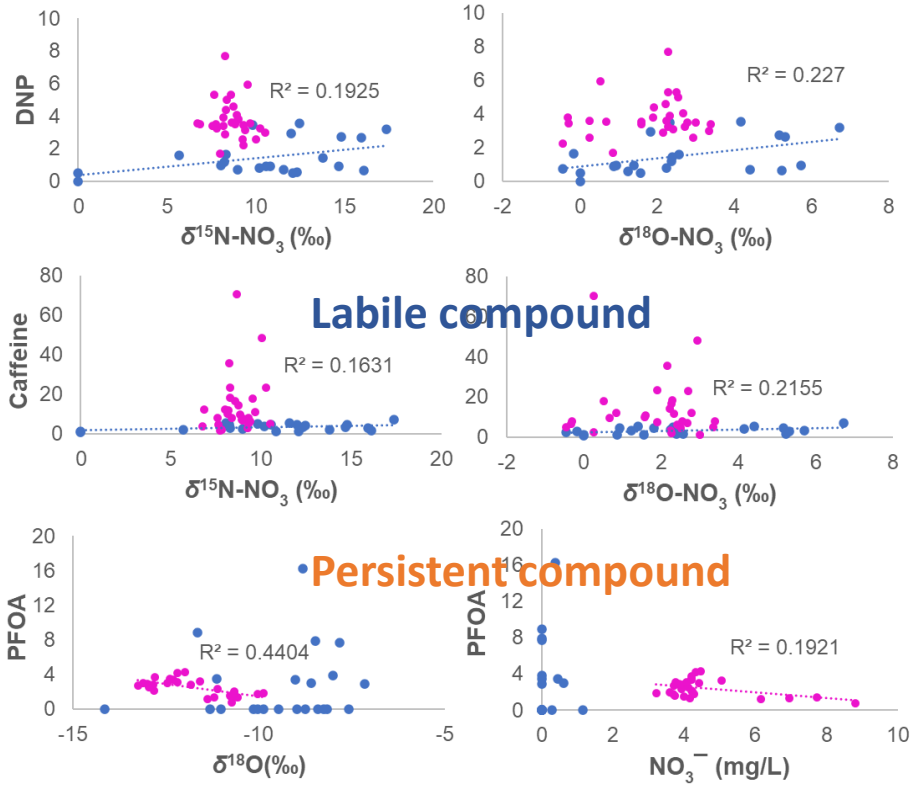


Nitrate isotopes

Nitrate pollution originated from soil water (groundwater)

CECs:

- improved hydrological processes interpretation
- supported tracing of nitrate sources and biogeochemical processes



Halder et al. 2022 Scientific Reports

What are the benefits of linking physical and chemical tracers?

Linking isotopes and CECs data can be used to:

- **Trace specific pollution sources in groundwater and surface water**
- **Improve understanding of pollutants pathways, e.g. anthropogenic/natural recharge, sewage leakages**
- **Understanding connection between components of water cycle**
- **Identify biological processes that impact pollutants in waters**

Study sites


Finland


France


Argentina


Ecuador


Malaysia


Spain


Pakistan


Greece


Burkina Faso


Ukraine

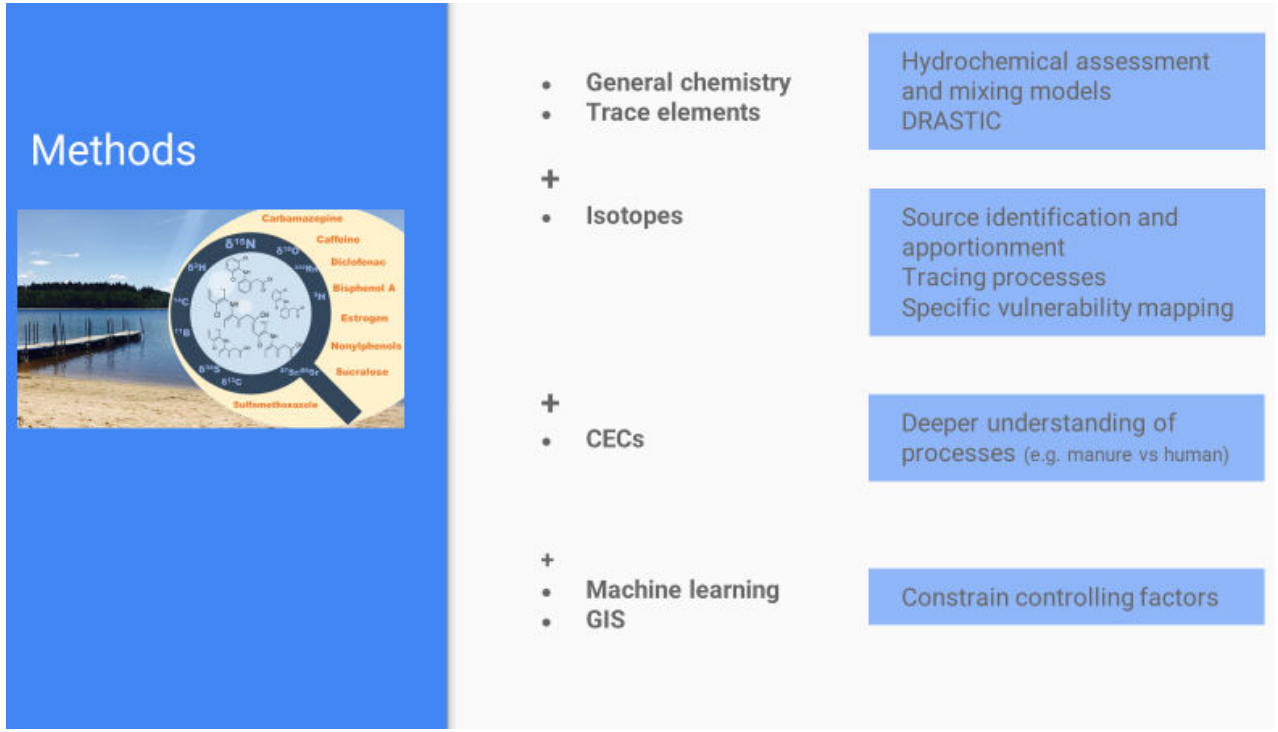

Australia


Cameroon


Nigeria

Df continental subarctic
Df humid continental
Cs Mediterranean
Cs Mediterranean
Cs Mediterranean
BS Hot semi-arid
BS hot semi-arid
Aw tropical savanna
Af tropical rainforest
Am tropical monsoon
BS hot semi-arid
Cf humid subtropical
Cf humid subtropical

Common approach



Why it is better to work together?

- Interdisciplinary and international cooperation
- Common approach for method validation
- Cover different geographical, socio-economic conditions and temporal scales (global perception)
- Common effort to transfer knowledge and experiences to stakeholders in Member States and support science-based water resources management (guidelines, training, outreach…)

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Thanks to our team and co-workers!

IAEA Coordinated Research Project Team

“Citizen Science” school team on CECs and isotopes in Danube River coordinated by Astrid Harjung and Leo Chavanne