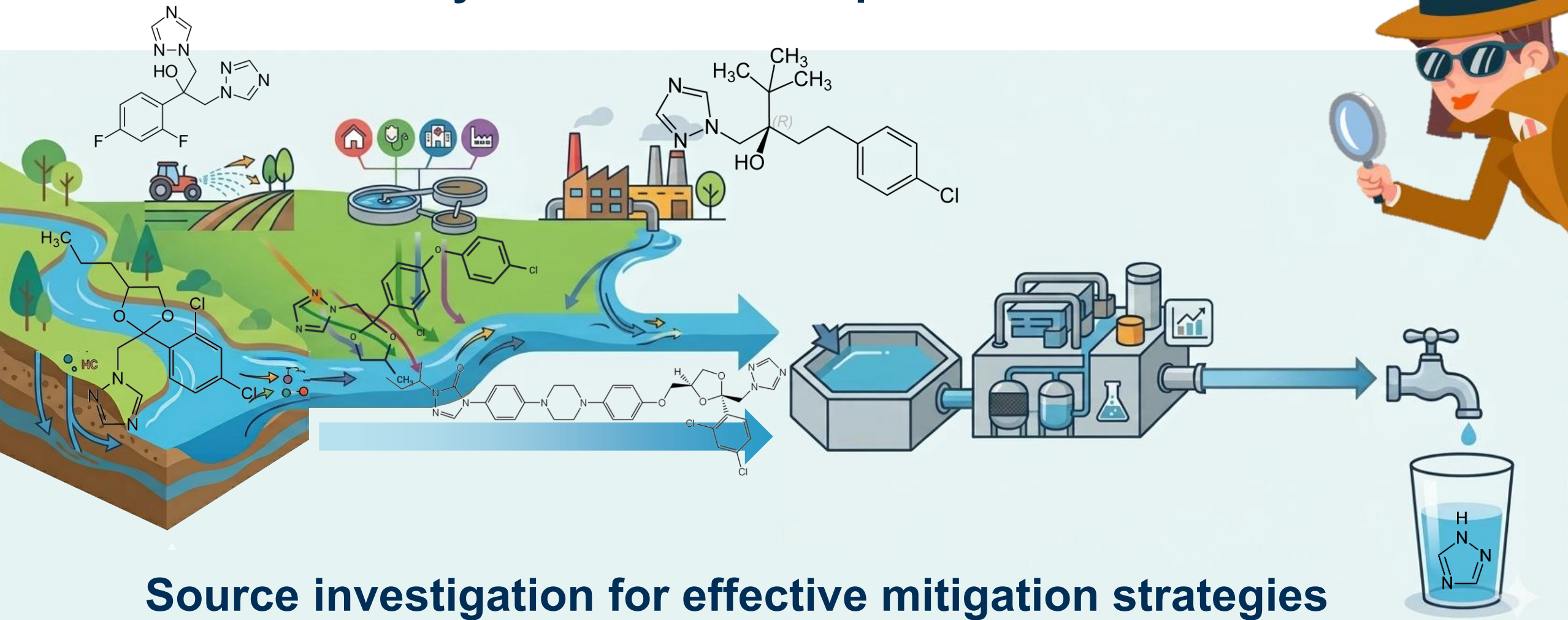


Tracing Sources of 1,2,4 Triazole in Flemish Drinking Water using a Combined Monitoring-Modelling Approach

XVIII Symposium on Pesticide Chemistry
Cremona, 2026

Liesa Brosens, Ingeborg Joris, Jan Jordens, Ingrid
Keupers, Tania Verhoeve, Kris Van Den Belt and Tom Diez

What if we only measure the endpoint?



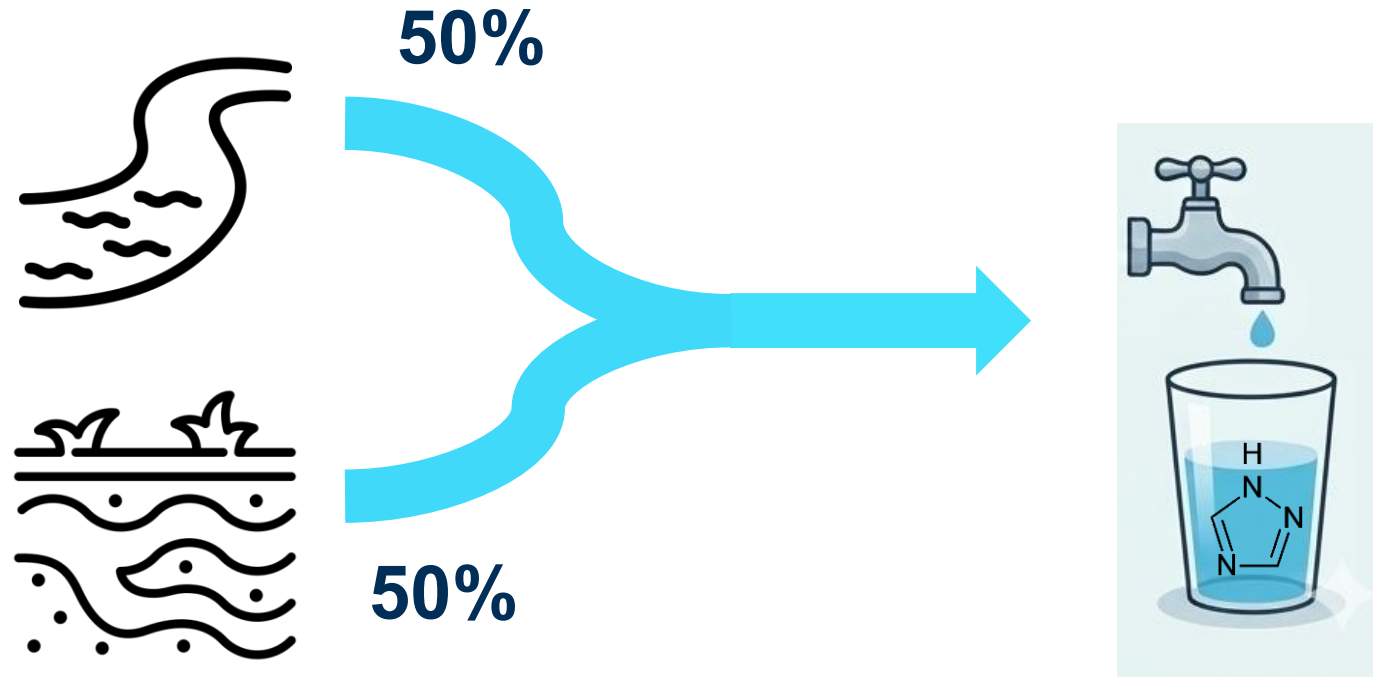
Source investigation for effective mitigation strategies

Surface water is extra vulnerable to contamination

Flanders

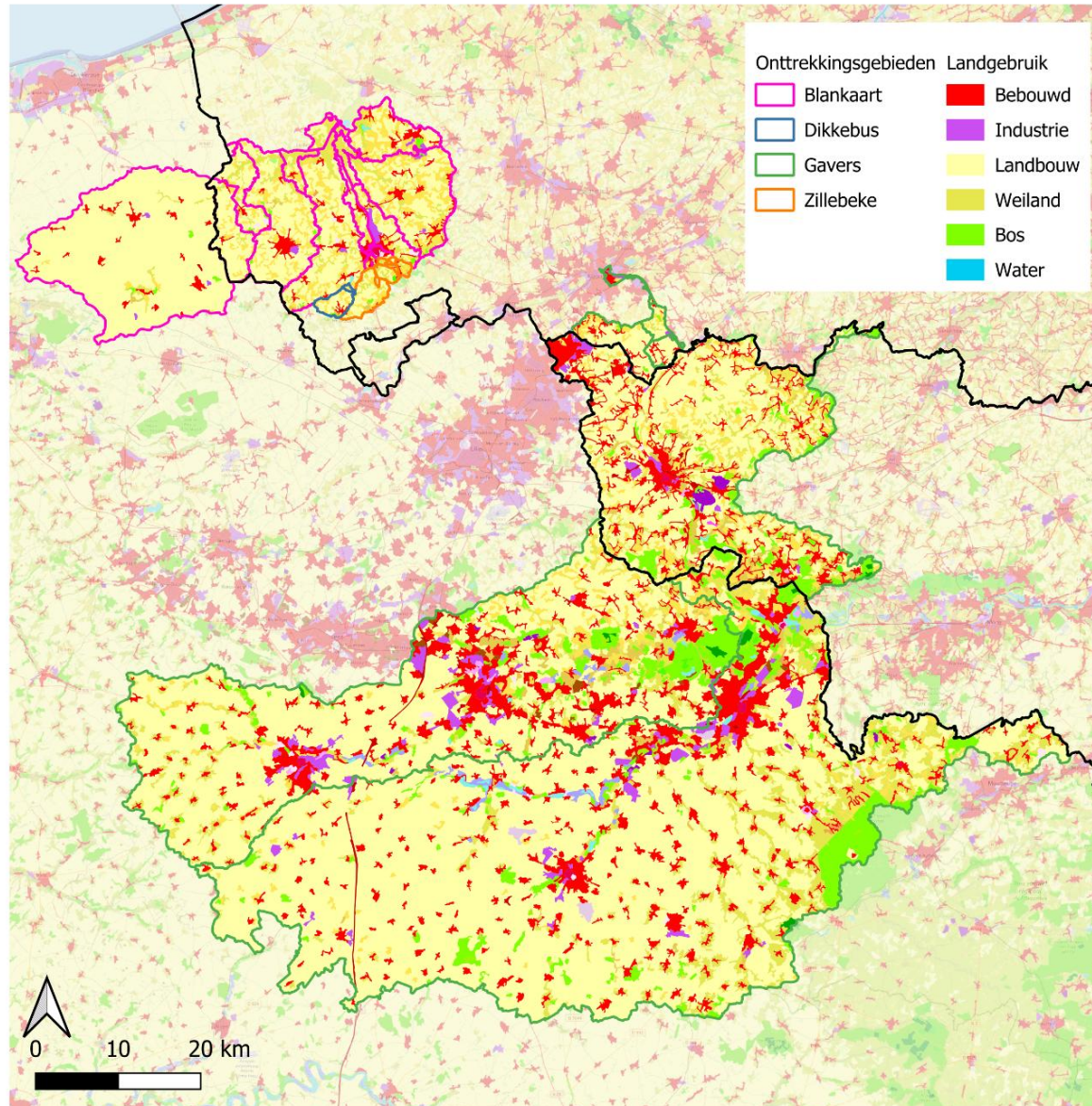


Drinking water sources



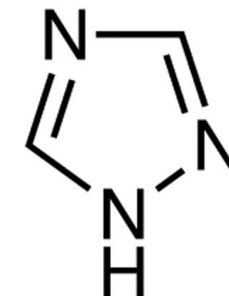
1,2,4-Triazole

Extraction areas drinking water from surface water



Source investigation: multi-method approach

1. Identification of potential sources 1,2,4-Triazole: Literature
2. Pathways to surface water
3. Spatial analysis of potential sources
 - Modelling diffuse agricultural inputs
 - Mapping point sources
4. Analysis monitoring data
 - Time-series analysis
 - Non-Target Analysis



1. Identification of potential sources

1,2,4-triazole = building block of fungicides

1. Pesticides: break down to 1,2,4-triazole in soil or water + authorized use

- Biocides tebuconazole and propiconazole for wood protection (industrial treatment, limited for exterior housing)
- Plant Protection Products 10 potential mother compounds

Wide authorized use!

Werkzame stof	Verkoop BE 2023 (kg)	Aantal producten	Aardappelen + pootgoedteelt	Sierplanten Sierbomen	Granen (winter + zomer)	Bieten (sulker + voeder)	Koolzaad (winter + zomer)	Groenten - kolen	Groenten - vruchtgewassen	Groenten - knolgewassen	Groenten - bladgroenten	Groenten - overige	Kruiden	Fruit	Fruitbomen	Gazons + Golfterreinen	Bosbouw
Amisulbrom	5.074	6	x	x													
Bromuconazole	2.244	2			x												
Difenoconazole	25.716	37	x	x	x	x	x	x	x	x	x	x	x	x	x		
Mefentrifluconazole	21.553	15	x		x	x	x		x					x	x		
Metconazole	3.860	20		x	x	x	x					x				x	
Paclobutrazol	6	2		x													
Penconazole	608	3		x					x					x	x		
Prothioconazole	62.885	93	x		x	x	x	x		x							
Tebuconazole	33.329	29		x	x		x	x	x	x		x			x		x
Tetraconazole	3.502	9		x	x	x						x					x

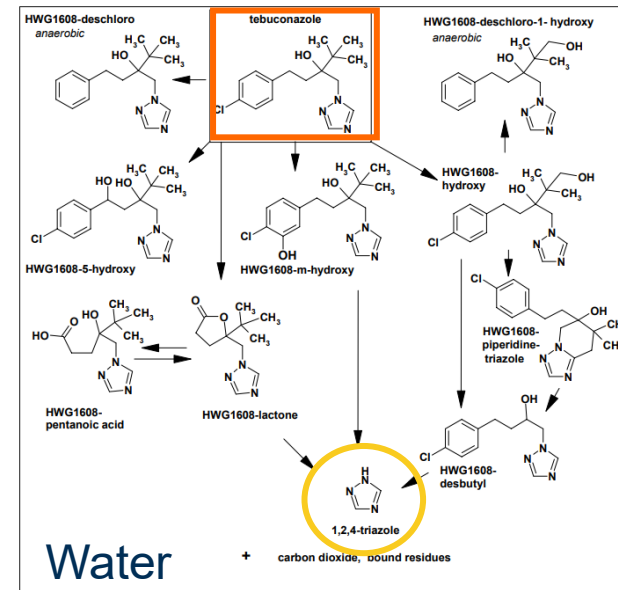
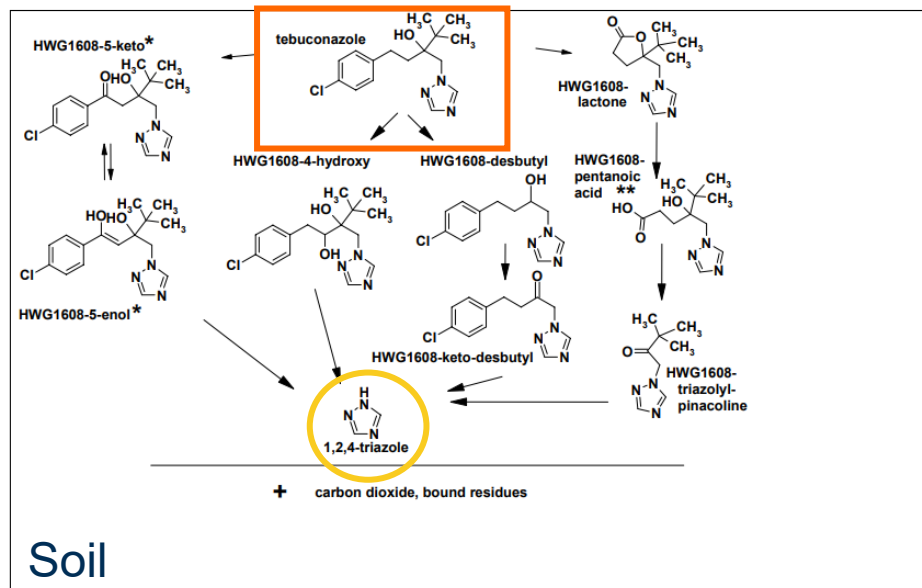
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- Biocides tebuconazole and propiconazole for wood protection (industrial treatment, limited for exterior housing)
- Plant protection products 10 potential mother compounds: amisulbrom, bromuconazole, difenoconazole, mefentrifluconazole, metconazole, paclobutrazol, penconazole, prothioconazole, tebuconazole and tetraconazole

Complex breakdown mechanisms with formation of intermediary products



Parent compound

≠ intermediary products

Final breakdown product: 1,2,4-triazole

vito.be

1. Identification of potential sources

1. Pesticides: break down to 1,2,4-triazole in soil or water + authorized use

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- **Plant protection products** 10 potential mother compounds: amisulbrom, bromuconazole, difenoconazole, mefentrifluconazole, metconazole, paclobutrazol, penconazole, prothioconazole, tebuconazole en tetraconazole

2. Pharmaceuticals

- **Human use** fluconazole and itraconazole, primary care + hospitals

3. Industrial discharges

- **Proceswater of companies** wood treatment, food processing

2. Pathways to surface water

1. Plant protection products

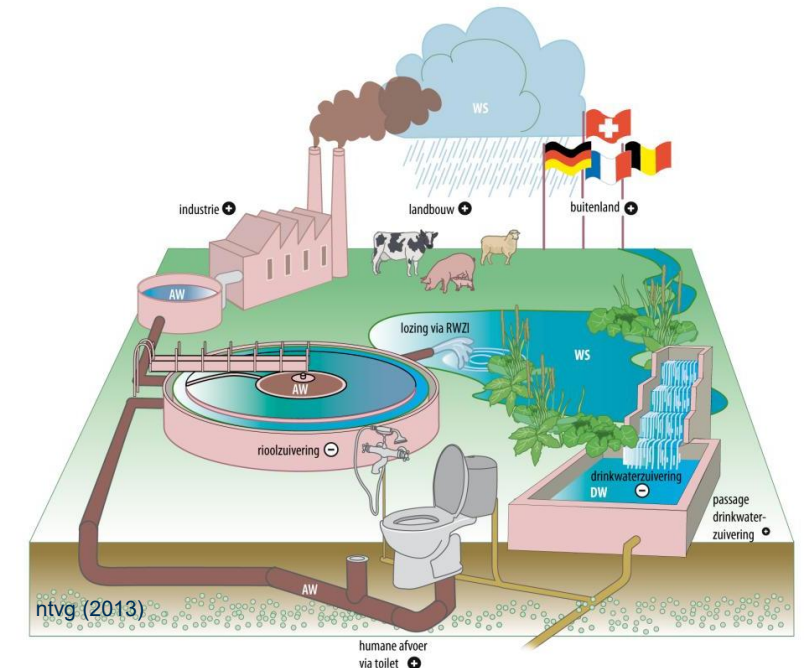
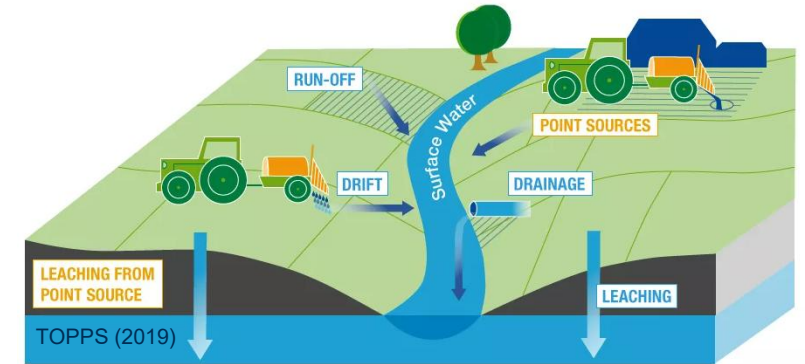
- Diffuse
 - Spray drift
 - Surface runoff and erosion
 - Drainage + groundwater
- Point sources

2. Pharmaceuticals – Human use

- Wastewater treatment plants (WWTP's)
- Untreated household wastewater

3. Industrial discharges (food processing + wood treatment)

- Direct discharge into surface water
- Waste water treatment plants (WWTP's)



3. Spatial analysis of potential sources

Diffuse inputs from Plant Protection Products

GOAL: Theoretical estimate of amount of 1,2,4-triazole to surface water

- Spatial pressure patterns
- Contributions per crop group

DATA:

- Selection of 10 mother compounds
 - Maximum authorized use (Belgium: Fytoweb, France: E-Phy)
 - Chemical properties: DT50, metabolization fraction in soil and water (EFSA-conclusion reports)
- Agricultural land use 2023 at parcel level (Flanders: Geopunt, Wallonia: WallonMap, France)

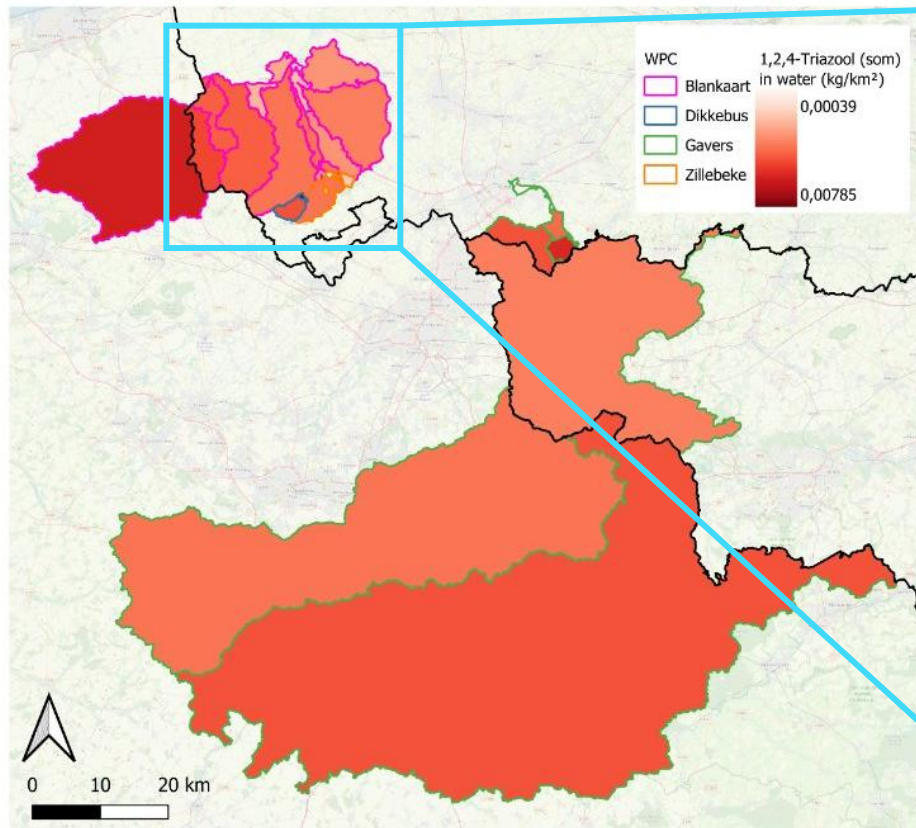
METHOD:

- Conservative estimates based on FOCUS STEP 1- surface water: erosion + drainage
- Total input = Sum of input from 10 mother compounds scaled for sales 2023 (BE and FR)

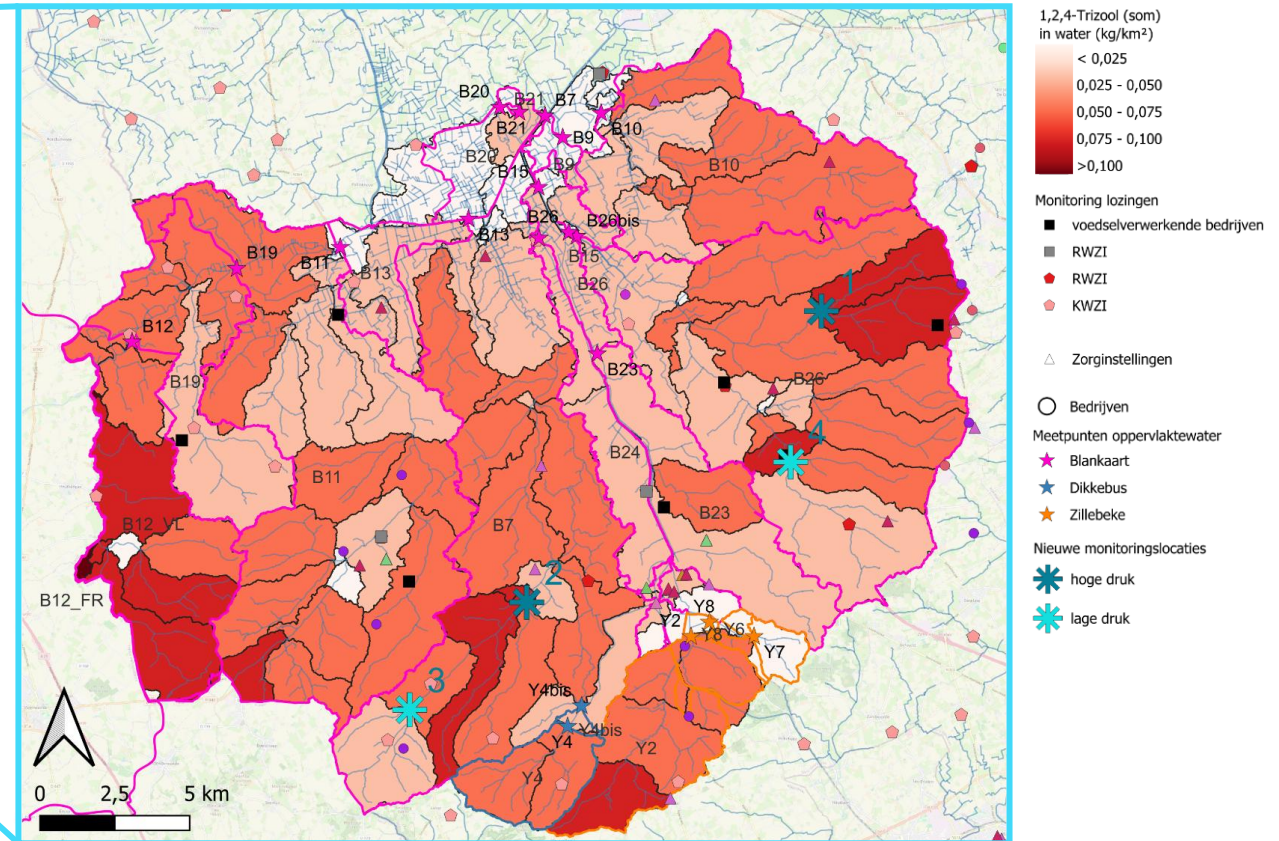
3. Spatial analysis of potential sources

Diffuse inputs from **Plant Protection Products**: Spatial pressure patterns

Current monitoring network



New monitoring locations



3. Spatial analysis of potential sources

Diffuse inputs from **Plant Protection Products**: Contributions per crop group

Majority of theoretical contributions from:

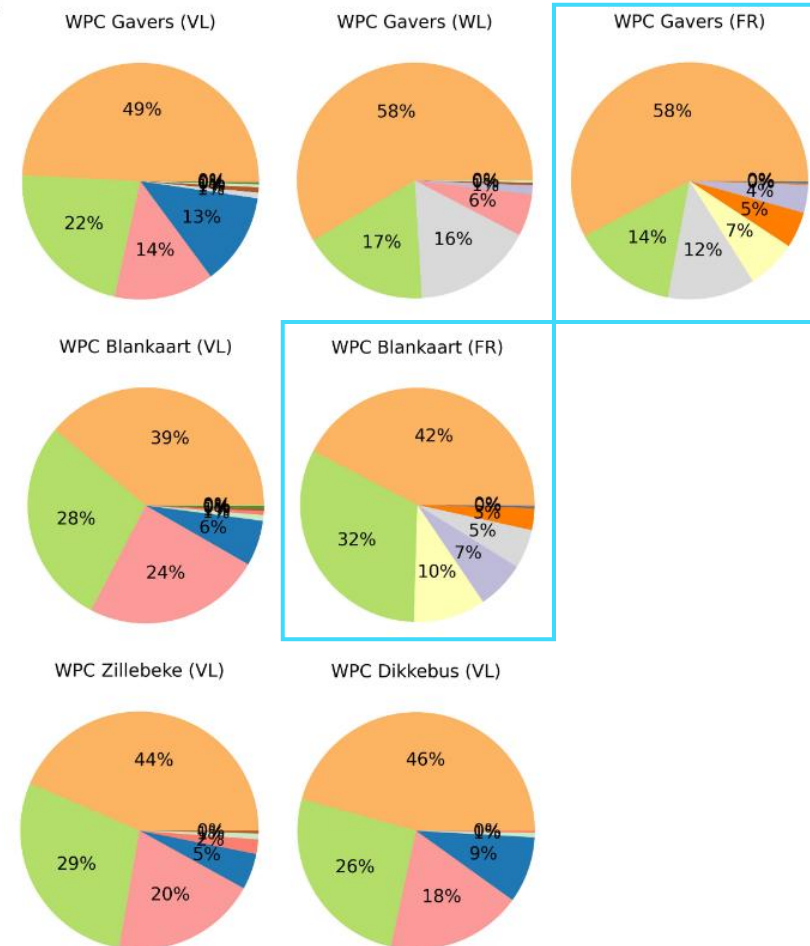
1. Cereal

2. Potatoes

3. Vegetables

France: also maize

1,2,4-Triazool (som) in water per gewasgroep

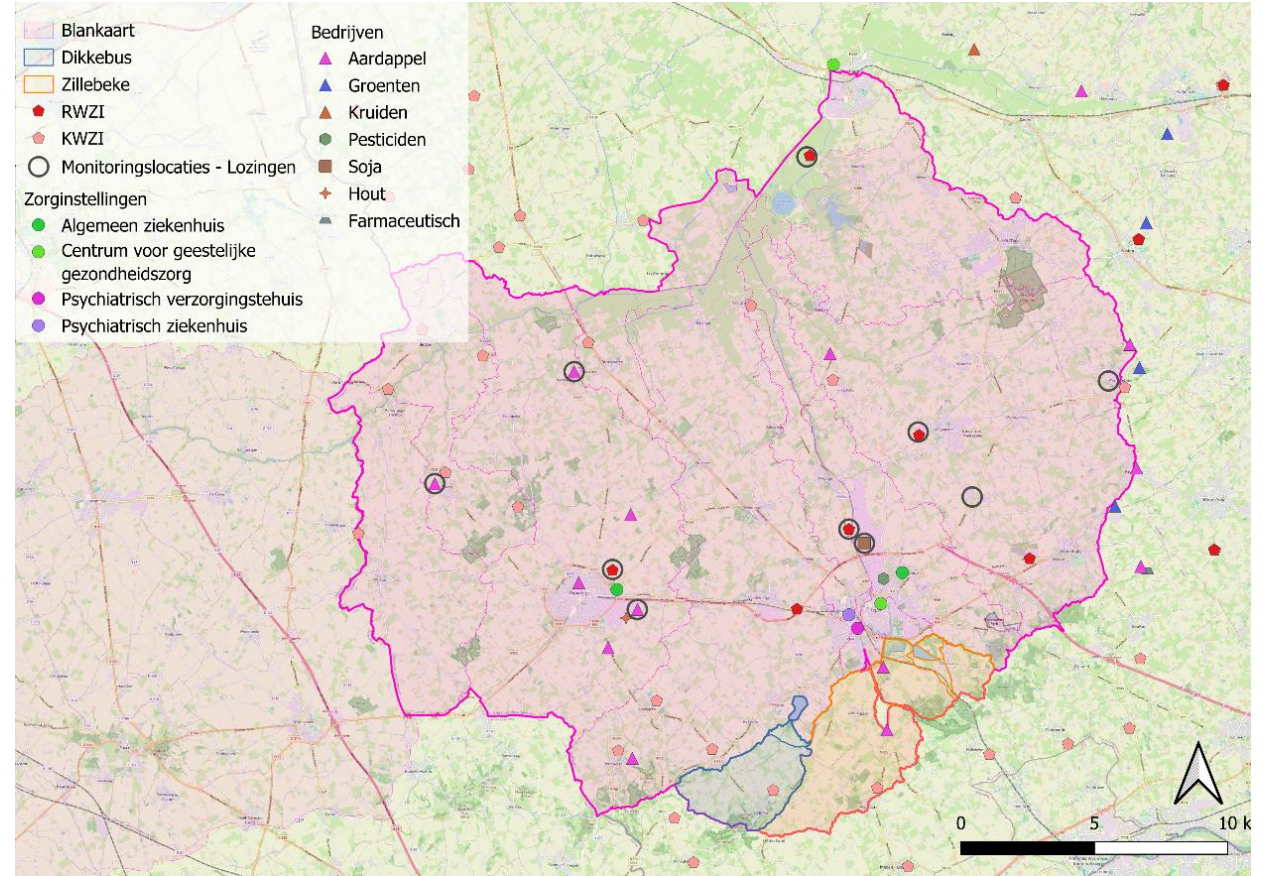


3. Spatial analysis of potential sources

Point sources: Pharmaceuticals and industrial discharges

Mapped for extraction areas:

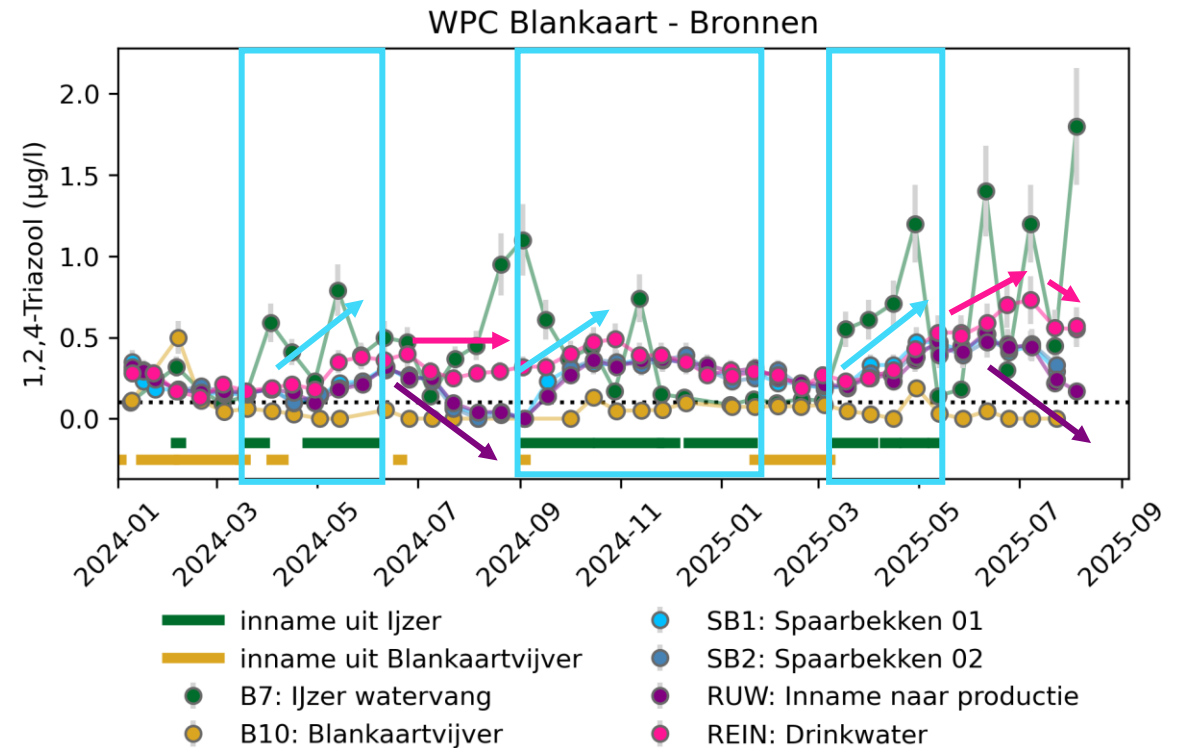
- Pharmaceuticals:
 - Healthcare facilities
 - WWTP's
- Industrial discharges:
Companies with
 - Food processing
 - Wood treatment
 - Pharmaceutical manufacturing
 - Pesticide manufacturing



4. Analysis monitoring data

WPC Blankaart: Sources and variation during drinking water production

- 2 sources: IJzer en Blankaartvijver
 - **Blankaartvijver**: usually $<0,1 \mu\text{g/l}$
 - **IJzer**: high concentrations up to $3 \mu\text{g/l}$, always $> 0,1 \mu\text{g/l}$



4. Analysis monitoring data

WPC Blankaart – variation along river IJzer

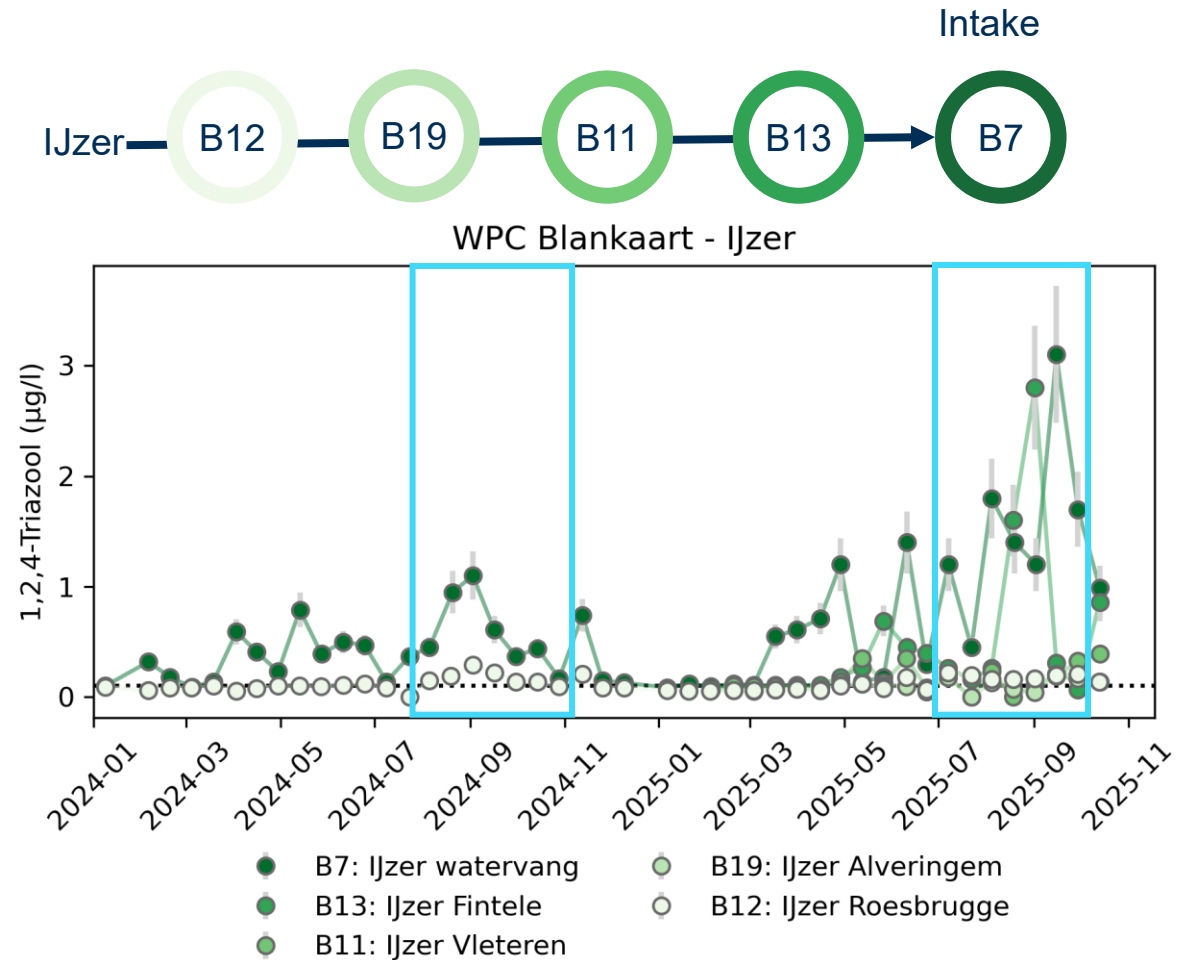
Measurements along river IJzer:

- **B12 – border FR:**

- Concentrations around 0,1 µg/l
- > 0,1 µg/l: July – October

- **B7: intake**

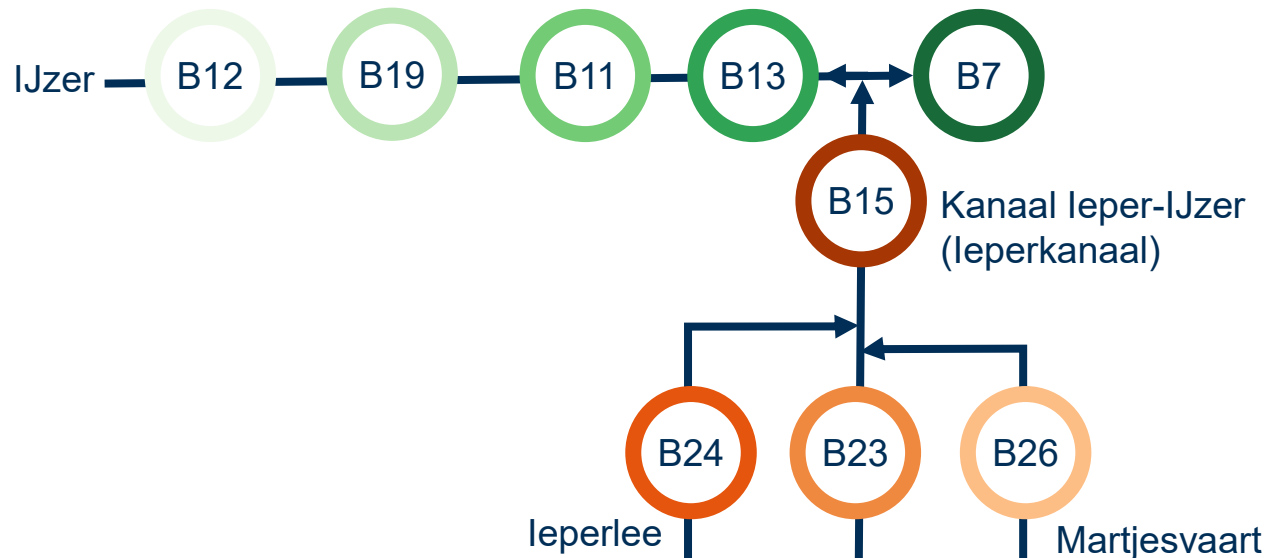
- Spring + summer: strong fluctuations in concentration ~ flow direction water
- Concentrations high when low in all upstream locations



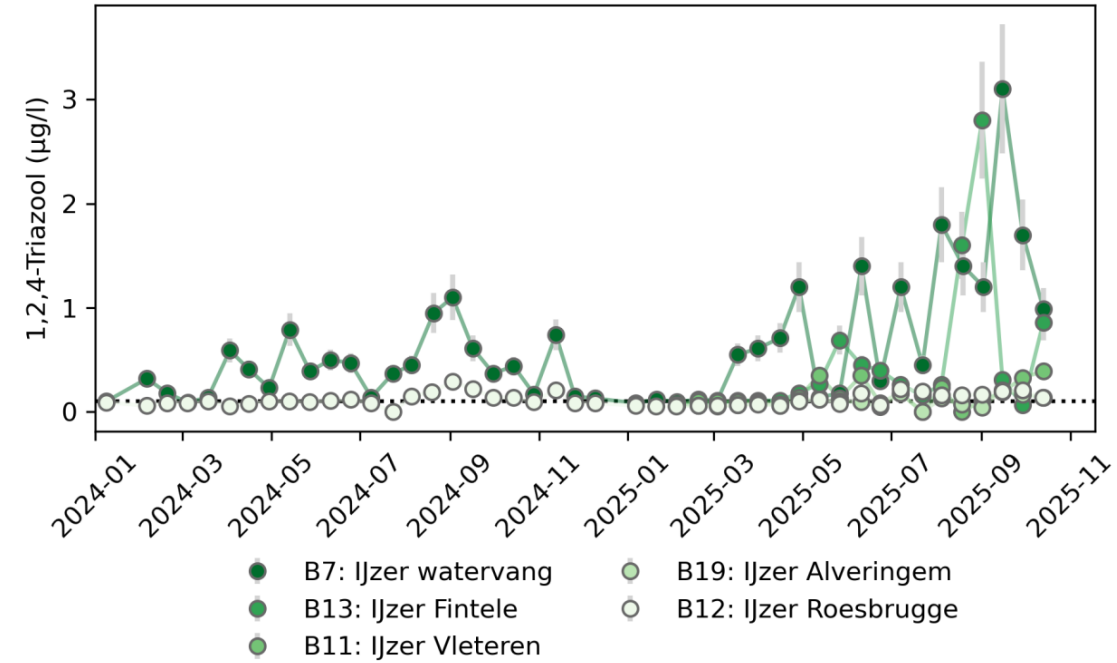
4. Analysis monitoring data

Variations along IJzer – Canal IJper-IJzer

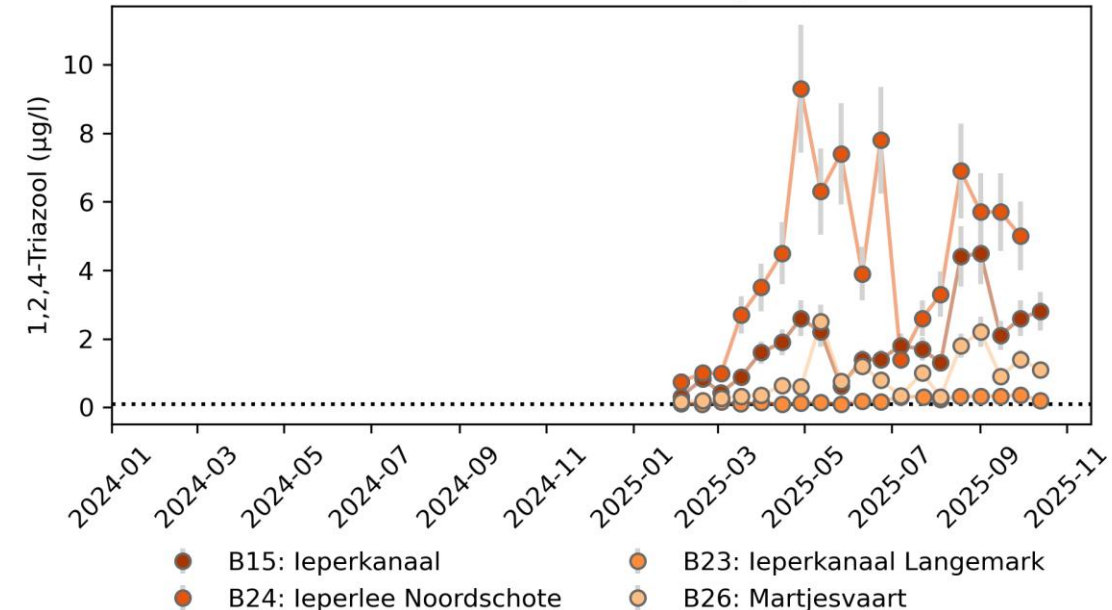
- Strong increase concentrations IJzer after leperkanaal
- High concentrations canal leper-IJzer, dominated by very high concentrations
- Linked to industrial discharges: industry + WWTP



WPC Blankaart - IJzer



WPC Blankaart - Kanaal IJper-IJzer



4. Analysis monitoring data

Contributions from discharges

Discharges:

- Different companies and WWTP direct discharge on leperlee + canal
- 3 measurement campaigns
 - 124T Industrial discharges: 0,2 – 32 µg /l
 - 124T WWTP effluent: 0,2 – 1,1 µg/l
 - Detection of *propiconazole* (biocide)
 - 124T wastewater hospital: 0,2 µg/l

Discharges have a dominant contribution to the high concentrations of 124-triazole in the IJzer river at the drinking water intake point

4. Analysis monitoring data

Non-target analysis

- Not all mother compounds measured with standard analysis
- Measured mother compound intake (*tebuconazole*) cannot explain increase in 1,2,4-concentrations during drinking water production
 - > Non-target analysis 1,2,4-triazole containing compounds in raw water

m/z meas.	Name	Molecular Formula	area
320.15313	Metconazole	C17H22ClN3O	4086
334.16948	(1R,2S,5R)-2-(4-chlorobenzyl)-5-isopropyl-1- (1H-1,2,4-triazol-1-ylmethyl)cyclopentanol	C18H24ClN3O	4708
318.13769	(5E)-5-[(4-chlorophenyl)methylidene]-2,2-dimethyl-1-(1,2,4-triazol-1-ylmethyl)cyclopentan-1-ol	C17H20ClN3O	10434
406.07291	1-[[2-[2-chloro-4-(4-chlorophenoxy)phenyl]-4-methyl-1,3-dioxolan-2-yl]methyl]-1,2,4-triazole	C19H17Cl2N3O3	8328
292.12168	cyproconazole	C15H18ClN3O	2862
308.15278	Tebuconazole	C16H22ClN3O	8790
318.09993	triadimenol	C14H18ClN3O2	1130
307.11323	Fluconazole	C13H12F2N6O	8356

(breakdown products)
Plant protection products

Pharmaceutical

Source investigation De Blankaart

Summary

- Elevated concentrations of 1,2,4-triazole in drinking water (max 0,7 µg/l)
- Dominant contribution from discharges (WWTP + industry)
- 1,2,4-triazole originates from multiple sources:
 - Discharges industry and WWTP
 - biocide, pharmaceutical and (breakdown products) of plant protection products
 - Agriculture
 - (breakdown products) plant protection products

Conclusion

- Multi-method source investigation framework:
 - Literature review
 - Spatial mapping and modelling
 - Targeted monitoring
 - Advanced analytical techniques: Non-Target Analysis
- Approach
 - enables water utilities to prioritize interventions
 - support regulatory exposure assessment for proactive risk management
 - transferable to other contaminants of emerging concern



Thank you!

Questions?

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