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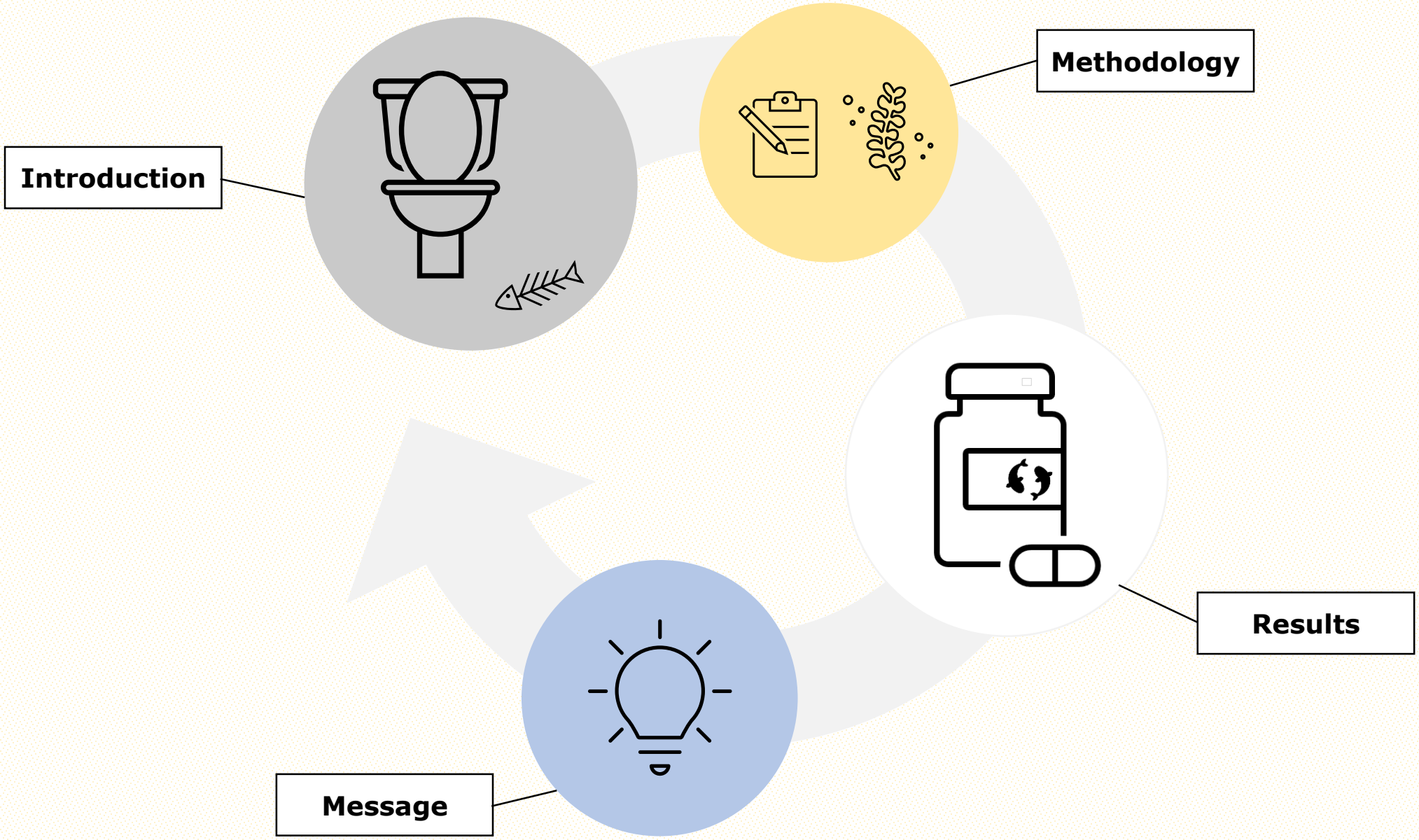
Faculté des géosciences
et de l'environnement

Developing an ecotoxicological classification for frequently used drugs in primary care

Dre med Tiphaine Charmillot
Tutors: Pre Nathalie Chèvre, Pr Nicolas Senn
Forum Ärztinnen und Ärzte für Umweltschutz
The 7th of May 2026


Introduction
Methodology
Results
Message

Micropollutants' regulation in Switzerland

Pesticides

1997

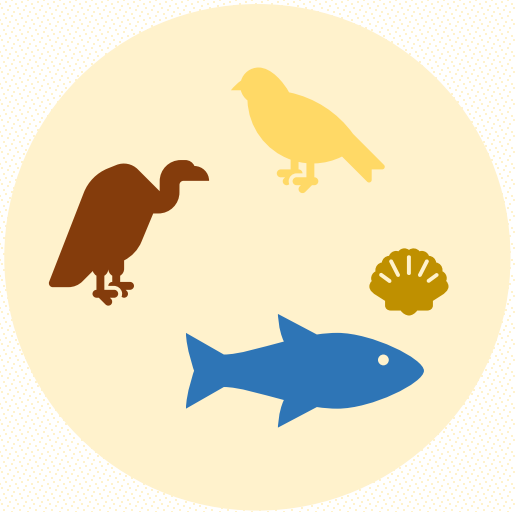
Pharmaceuticals

??

Swiss Federal Council. Ordonnance sur les paiements directs versés dans l'agriculture (Ordonnance sur les paiements directs, OPD). Fedlex, The publication platform for federal law, Swiss Federal Council; 2000.

Drugs' *direct* impact on ecosystems

- Chloroplast development impairment
- Vegetable growth inhibition



- Acute tubular necrosis
- mRNA modifications
- Embryotoxicity
- Morphological changes of reproductive organs

Zhang X, Yan S, Chen J, Tyagi RD, Li J. Physical, chemical, and biological impact (hazard) of hospital wastewater on environment: presence of pharmaceuticals, pathogens, and antibiotic-resistance genes. In: Current Developments in Biotechnology and Bioengineering
Li WC. Occurrence, sources, and fate of pharmaceuticals in aquatic environment and soil. Environ Pollut. 2014;187:193-201.
Carter LJ, Williams M, Martin S, Kamaludeen SPB, Kookana RS. Sorption, plant uptake and metabolism of benzodiazepines. Science of The Total Environment. 2018;628-629:18-25.
Katsikaros AG, Chrysikopoulos CV. Occurrence and distribution of pharmaceuticals and personal care products (PPCPs) detected in lakes around the world - A review. Environmental Advances. 2021;6:100131.
Mackuľak T, Černanský S, Fehér M, Birošová L, Gál M. Pharmaceuticals, drugs, and resistant microorganisms — environmental impact on population health. Current Opinion in Environmental Science & Health. 2019;9:40-8.

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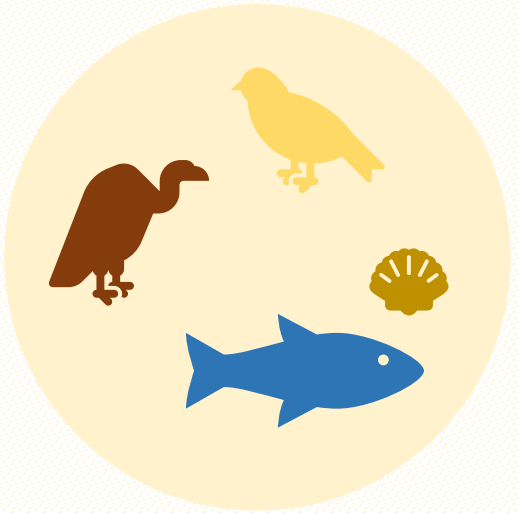

- Acute tubular necrosis
- mRNA modifications
- Embryotoxicity
- Morphological changes of reproductive organs

- Antibiotic resistance
- Immunosuppression
- Teratogenicity
- Fertility disregulation

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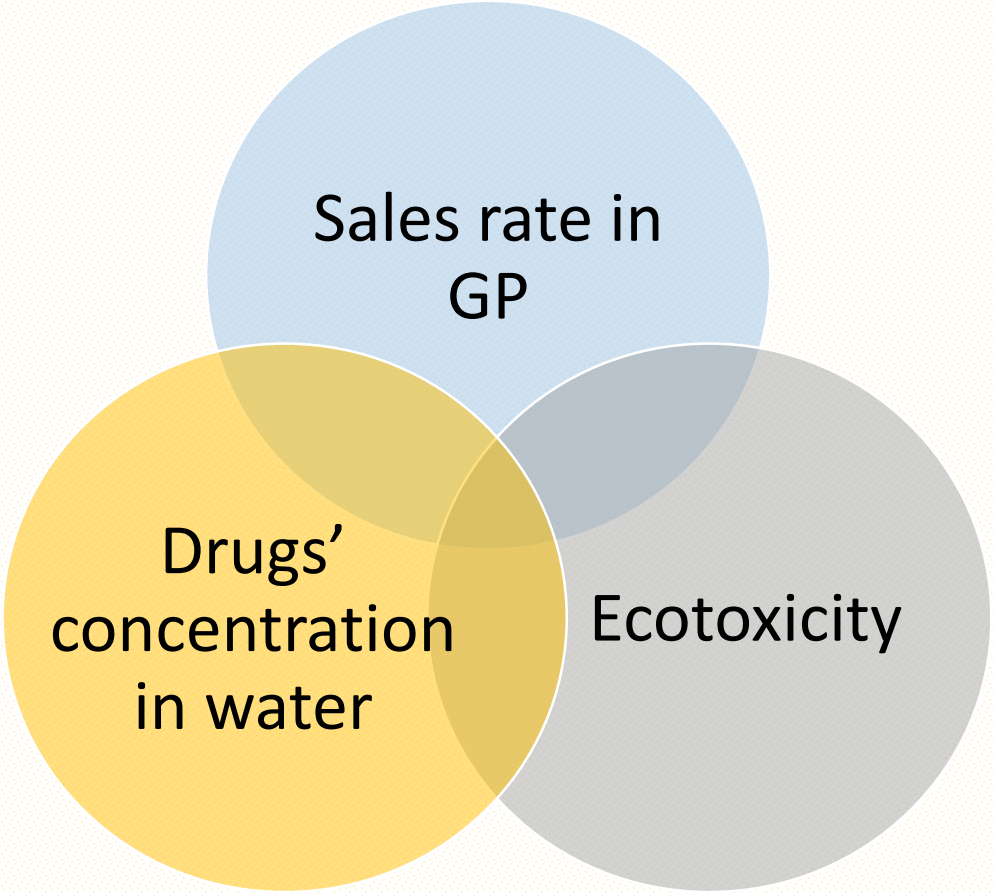
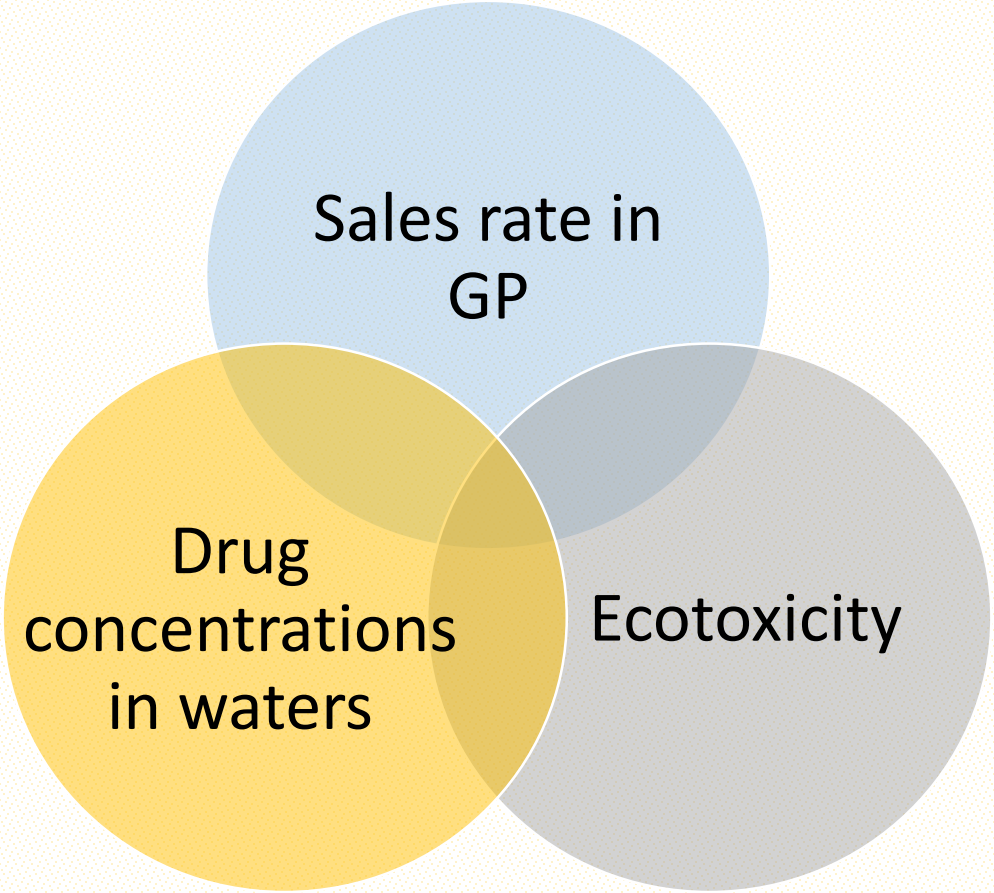
Methodology



Methodology

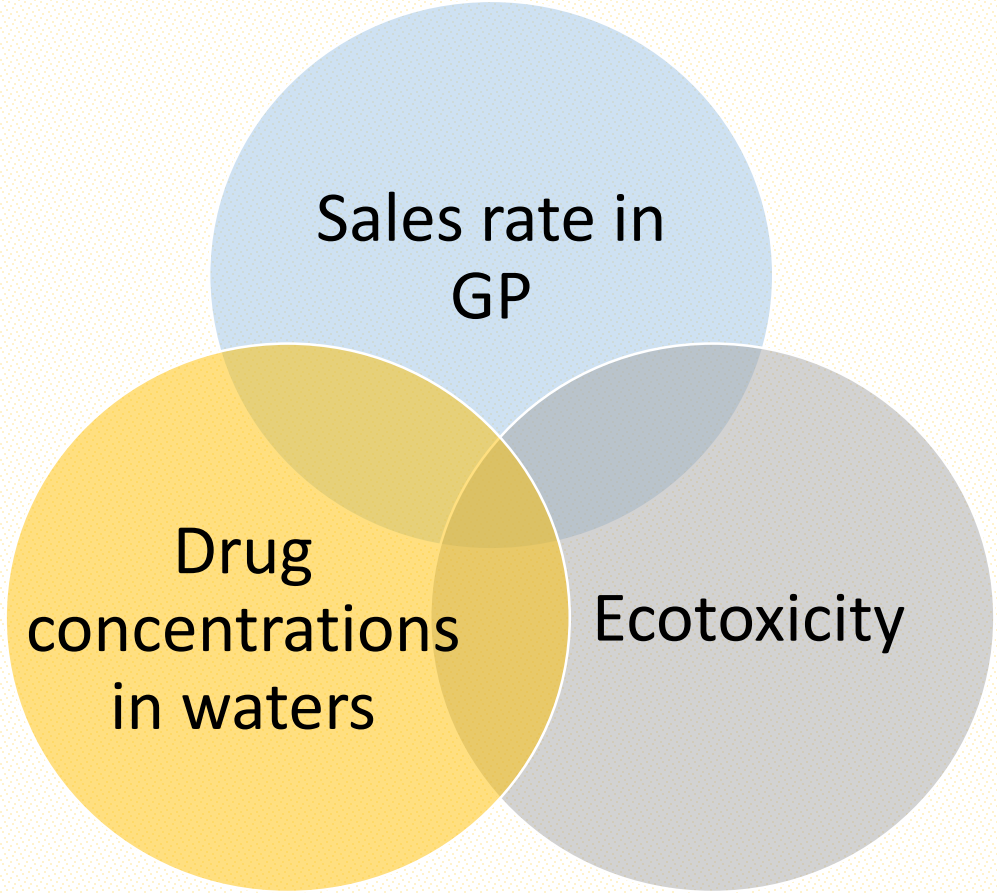


Watch list EU

Watch list NAWA

https://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:32022D1307&from=EN
https://sll.sitevision.se/download/18.7ea3e81f166a3423a9d1b00f/1540468908295/Table-of-environmentally-hazardous-drug-substances-SLL-2017-2021.pdf
https://www.bafu.admin.ch/bafu/fr/home/themes/eaux/publications/publications-eaux/eaux-suisses.html

Methodology



CIPEL (Léman)

DIREV (Vaud rivers)

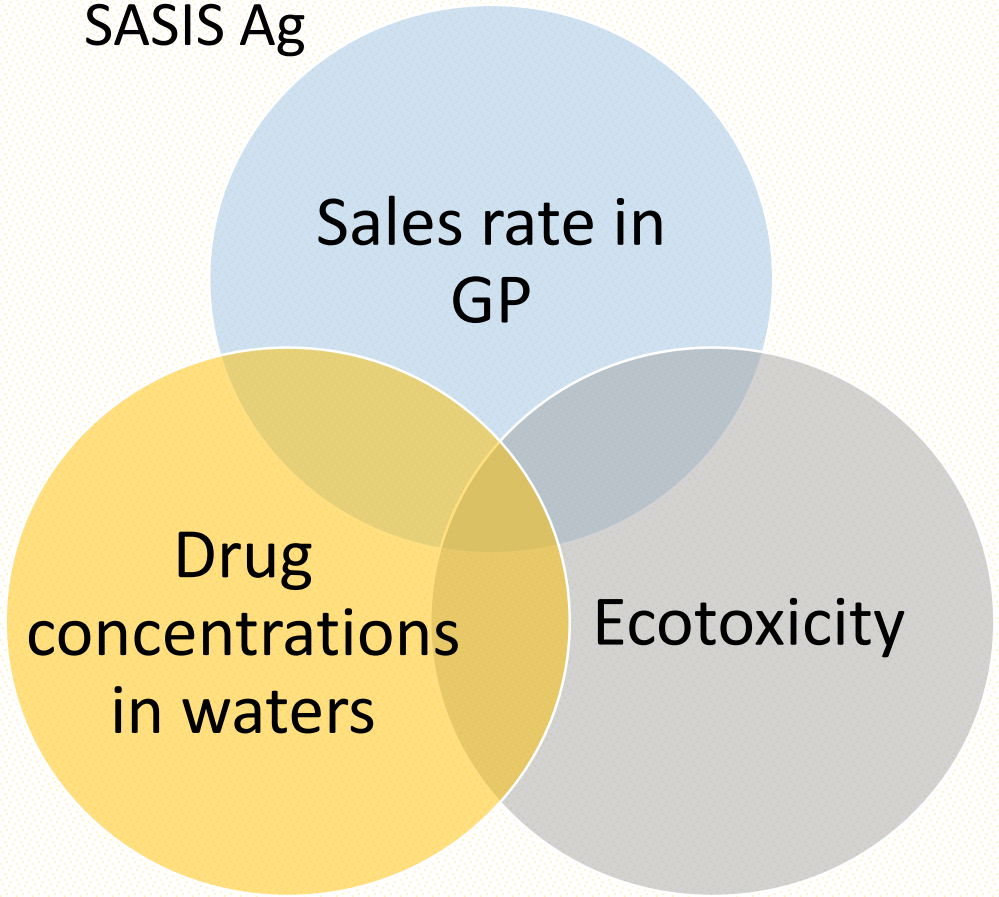
Watch list EU

Watch list NAWA

CIPEL - Commission internationale pour la protection des eaux du Léman. Eawag_Résultats_CIPEL_LCMS_LacLeman2021. 2023
Division protection des eaux (DGE-PRE) Division Assainissement (DGE-ASS). Stratégie de surveillance et de protection de la qualité des eaux superficielles. In: DIREV DdtedleDDdleiuer, editor.: Canton de Vaud; 2019.
Division protection des eaux (DGE-PRE) Section épuration urbaine. Micropolluants dans les stations d'épuration vaudoises. In: Département de l'environnement et de la sécurité DGE Direction de l'environnement industriel urbain et rural, editor.: Canton de Vaud; 2019.

Methodology

SASIS Ag



CIPEL (Léman)

DIREV (Vaud rivers)

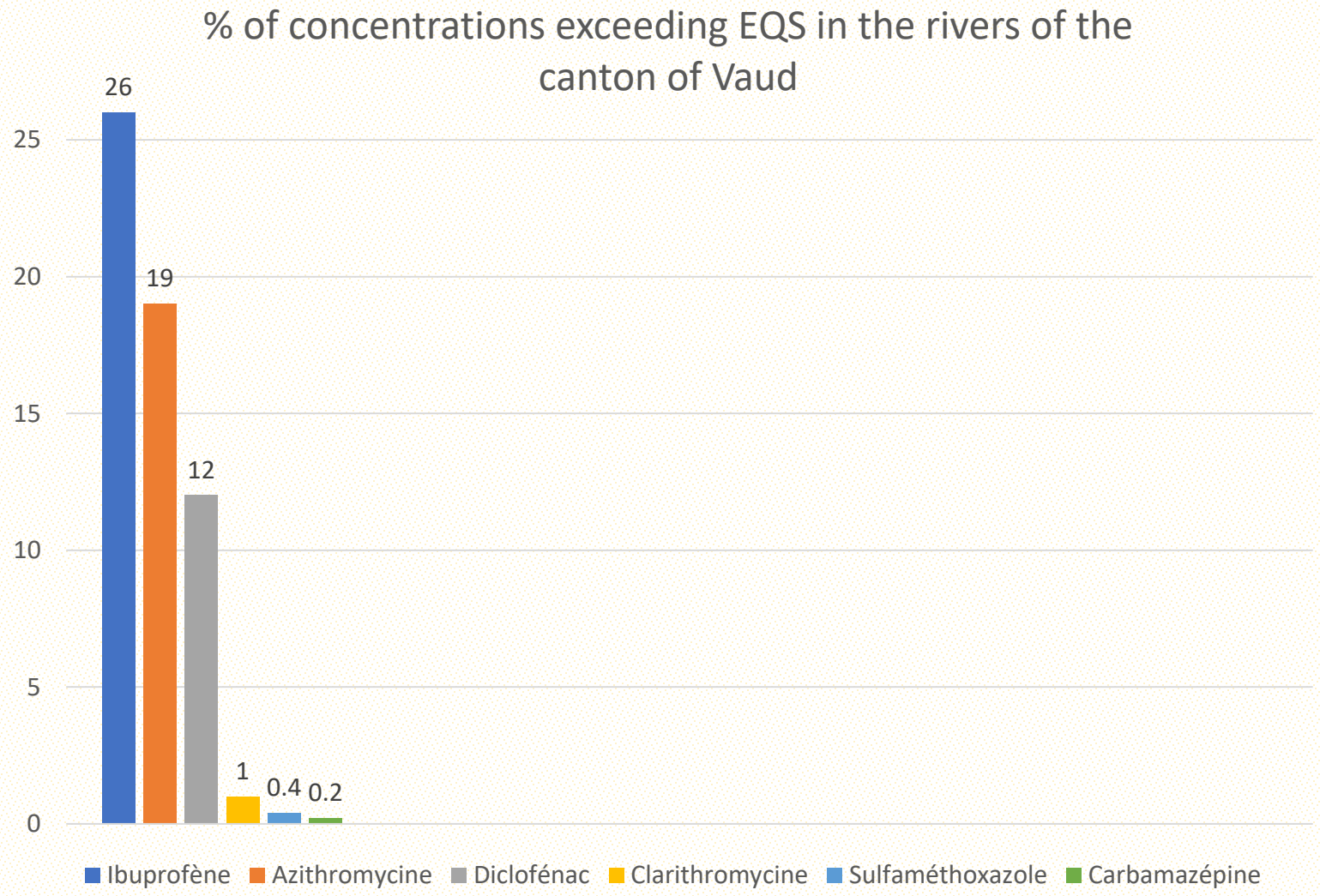
Watch list EU

Watch list NAWA

Most sold drugs in primary care in Switzerland (SASIS AG)

1)	Metformine	35'000 kg	
2)	Ibuprofène	21'500 kg	
3)	Paracétamol	20'900 kg	
4)	Métamizole	11'000 kg	
5)	Aspirine	8'100 kg	
6)	Méfénacid	3'200 kg	
7)	Allopurinol	2'900 kg	
8)	A. valproïque	2'900 kg	
9)	Lévétiracetam	2'800 kg	
10)	Carbamazépine	2'400 kg	
11)	Pantoprazole	2'200 kg	
12)	Métoprolol	2'100 kg	

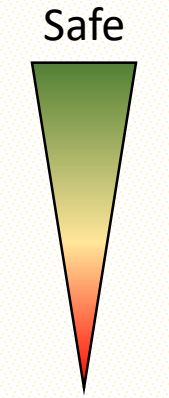
Most concentrated drugs in surface waters



Classification

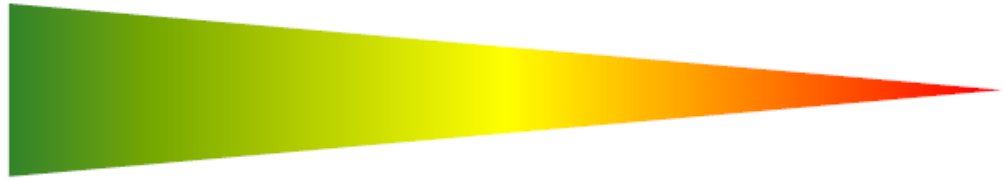
31 drugs classified

6 levels of recommendation (from the safest to the most detrimental to the environment):



1. Drugs with concentrations in Lake Geneva and rivers of canton of Vaud < 10x their toxic potential ($EQS \cdot 10^{-1}$)
2. Drugs with concentrations > $EQS \cdot 10^{-1}$ but < EQS ($EQS \cdot 10^{-1} < C < EQS \cdot 10^{-1}$)
3. Drugs with concentrations > $EQS \cdot 10^{-1}$ but < EQS and that are listed in the NAWA or in the EU Watch list
4. Drugs with concentrations > EQS
5. Drugs with concentrations > EQS and that are listed in the NAWA or in the EU Watch list
6. Drugs with incomplete data (measurement or EQS), but which are in the top 50 most sold drugs in primary care

Table 3. Ecotoxicological classification of most sold drugs in primary care in Switzerland (Author: T. Charmillot, 2025).

LOWER RISK						HIGHER RISK
	Category 1 $C < EQS \times 10^{-1}$	Category 2 $EQS > C > EQS \times 10^{-1}$	Category 3 $EQS > C > EQS \times 10^{-1}$ and listed by NAWA or the EU Watch list	Category 4 $C > EQS$	Category 5 $C > EQS$ and listed by NAWA or the EU Watch list	Category 6 Top 50 most sold drugs, incomplete data
ANESTHETICS						**Lidocaine**
ANTACIDS						**Esomeprazole** **Magaldrate** **Pantoprazole**
ANTIARRHYTHMICS						**Amiodarone**
ANTIBIOTICS	Ofloxacin ** Sulfadiazine	Erythromycin Metronidazole	Clindamycin ** Trimethoprim **	Clarithromycin	Azithromycin * **Ciprofloxacin *** Sulfamethoxazole **	**Amoxicillin**
ANTIDEPRESSANTS	Amisulpride *** Citalopram *** Mirtazapine		**Venlafaxine ** **			**Sertraline *** **Trazodon** **Trimipramin**
ANTIDIABETICS	**Metformin ** **					**Gliclazid**
ANTIEPILEPTICS	**Gabapentin ***** **Lamotrigin ***** Primidone			**Carbamazepine**		**Levetiracetam ***** **Oxcarbazepine** **Pregabalin** **Valproic acid**
ANTIHYPERTENSIVES AND BETA-BLOCKERS	Atenolol Candesartan **Irbesartan**	**Metoprolol** Propranolol	Sotalol ***			**Losartan** **Valsartan**
NSAIDs and PAINKILLERS	**Paracetamol** **Tramadol *****	Ketoprofen **Mefenamic acid Naproxen**			**Diclofenac *** **Ibuprofen ***	**Acetylsalicylic acid** **Celecoxib** **Etodolac** **Mesalazin** **Metamizole**

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LOWER RISK  HIGHER RISK

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ANTIDEPRESSANTS	Amisulpride *** Citalopram *** Mirtazapine		**Venlafaxine** **			**Sertraline** * Trazodon **Trimipramin**
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ANTIPLATELETS						**Clopidogrel**
ANTIVIRALS						**Valaciclovir**
DIURETICS	Hydrochlorothiazide ***					
HYPOURICEMICS						**Allopurinol**
IODINATED CONTRAST AGENTS				**Iomeprol**	**Iopromide** ***	**Iobitridol Iohexol**
LIPID-LOWERING AGENTS						**Atorvastatine Fenofibrat Rosuvastatine**
NEUROLEPTICS						**Lithium Quetiapine**
SPASMOLYTICS						**Mebeverin Tolperisone**
VENOTONICS						**Diosmine**

* NAWA; ** Watch List EU; *** potentially ecotoxic: EQS not validated but listed by NAWA; **bold**: top 50 most sold in primary care.

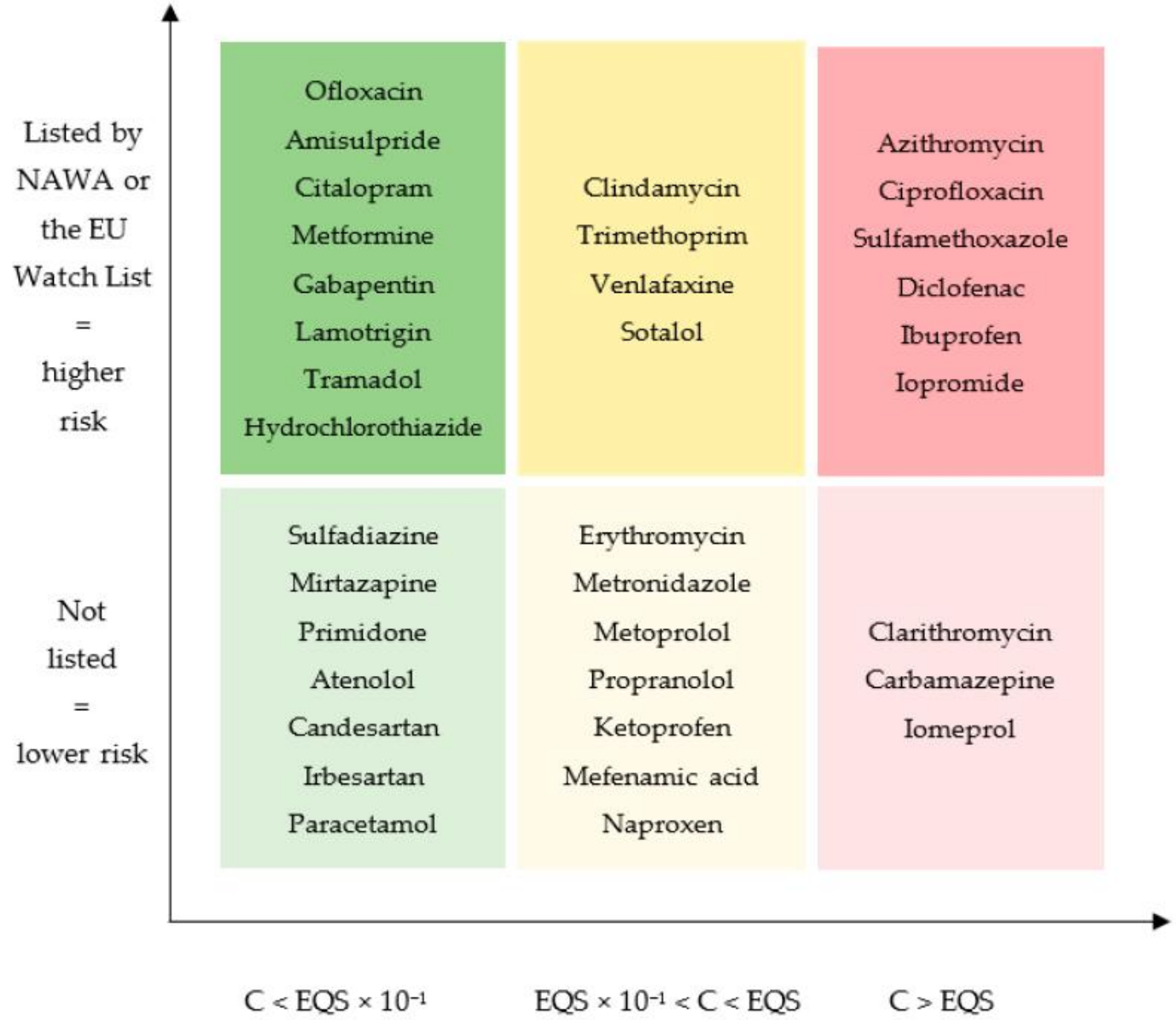


Figure 1. Ecotoxic classification of most sold drugs in primary care in Switzerland (Author: T. Charmillot, 2025). This classification is based on API concentrations effectively measured in

But how can one integrate these information in the every-day clinical reality ?

Age
Gender
Comorbidities
Drug interactions

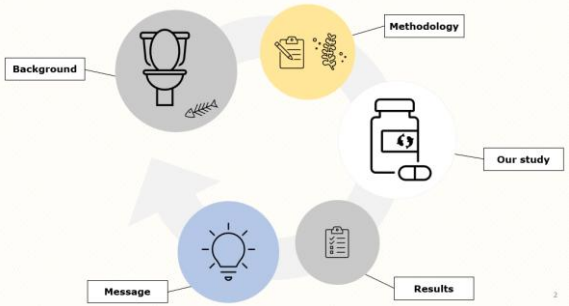
Patient wish
Side effects
Efficiency
Cost-effectiveness
Adhesion

Physical therapy
Psychotherapy
Social rehabilitation
Phytotherapy
RICE protocol

Is the molecule in this classification?
How is it classified?
Is there a safest molecule?

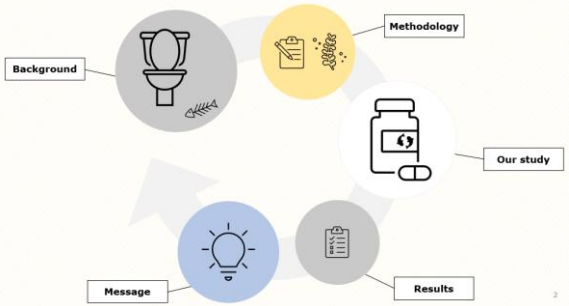
Minimum effective dose ?

Take home messages



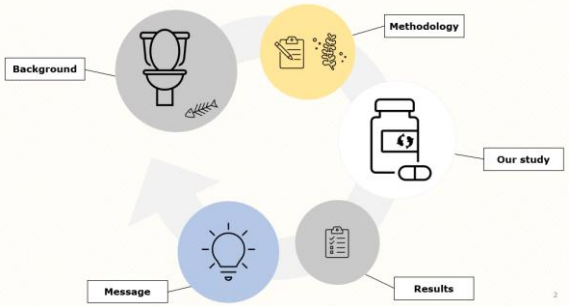
- Significant ecotoxical **differences** exist between drugs of the same class

Take home messages



- Significant ecotoxical **differences** exist between drugs of the same class
- Lack of **research** and **legislation** on pharmaceutical micropollution

Take home messages



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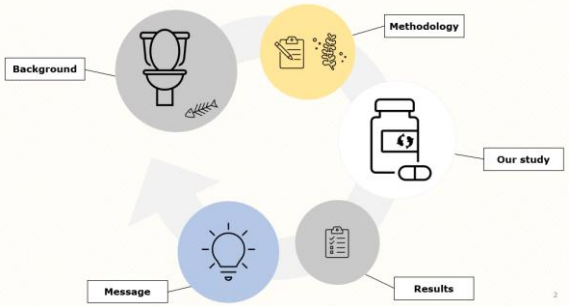
- Most hazardous drugs (C > EQS): azithromycine, ciprofloxacine, clarithromycine, sulfamethoxazole, carbamazepine, diclofenac, ibuprofene, iopromid, iomeprol

Take home messages



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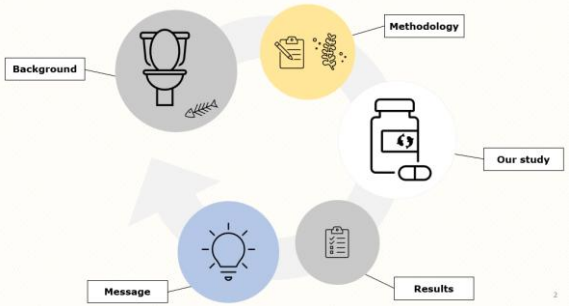
- Safest drugs (C < 10x EQS): ofloxacin, sulfadiazine, amisulpride, citalopram, mirtazapine, primidone, metformine, gabapentine, lamotrigine, candesartan, irbesartan, atenolol, hydrochlorothiazide, tramadol, paracetamol

Take home messages



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- **Physicians and pharmacists**, play a key-role in ecotoxicity. They thus need tools to minimize environmental pollution

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