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*The activity has been implemented within the framework of national project
Information and providing advice on improving the quality of environment in Slovakia.
The project is cofinanced by Cohesion Fund of the EU under Operational programme Quality of Environment.*

Transboundary loading of priority substances and emerging compounds from contaminated wastewater: a risk to fulfill the requirements of EU WFD

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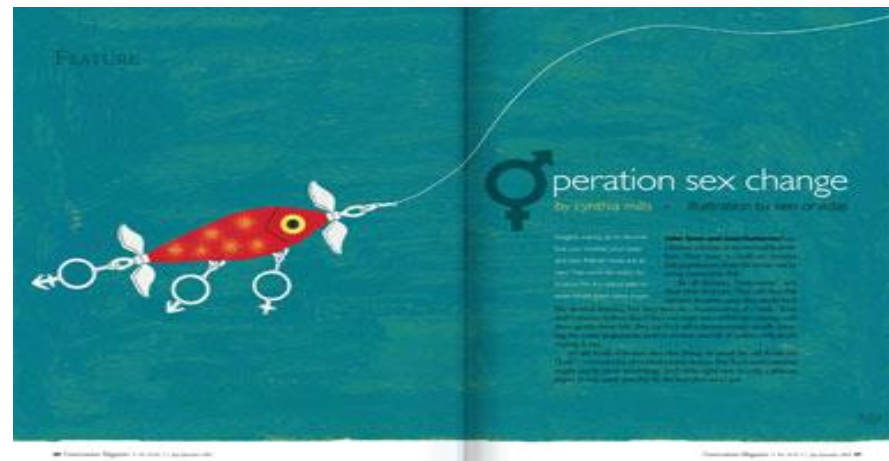


Priority substances

- **Water Framework Directive (WFD, 2000/60/EC)**: achieve and maintain **good chemical and ecological status** of surface and groundwater.
- **Environmental quality standards** (based on annual average and maximum allowable concentrations) for **45 priority** group of substances.
- **the EU Watch List** was established on monitoring other potentially harmful substances (Decision 2015/495/EC).

Emerging pollutants

- Not a part of Water Framework Directive (WFD, 2000/60/EC) or other water quality regulations:
- most of pharmaceuticals
- phenolic compounds and their metabolites
- manufactured nanoparticles
- microplastic...



Persistence and risk

Aquatic organisms and humans

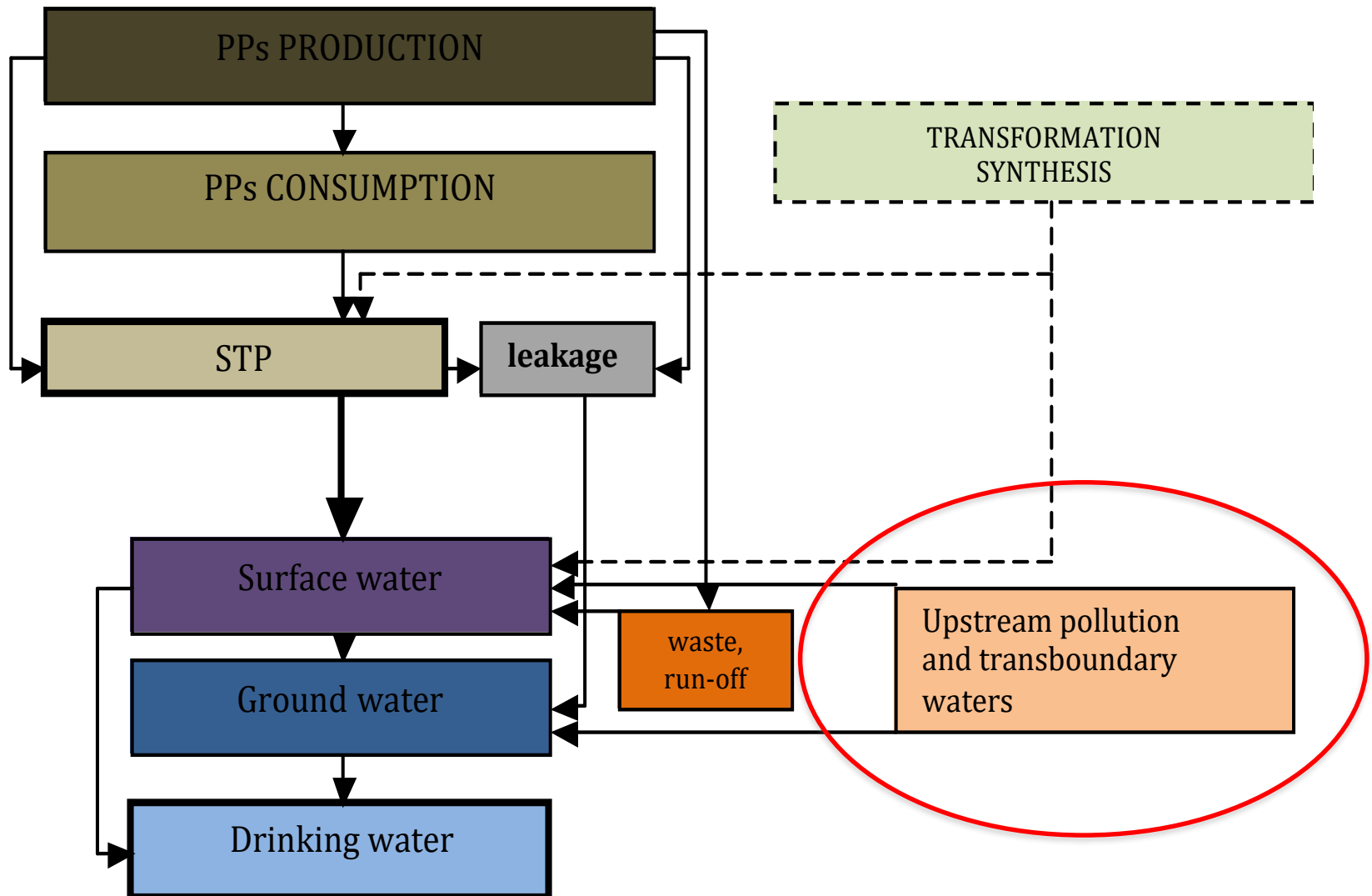


Effect

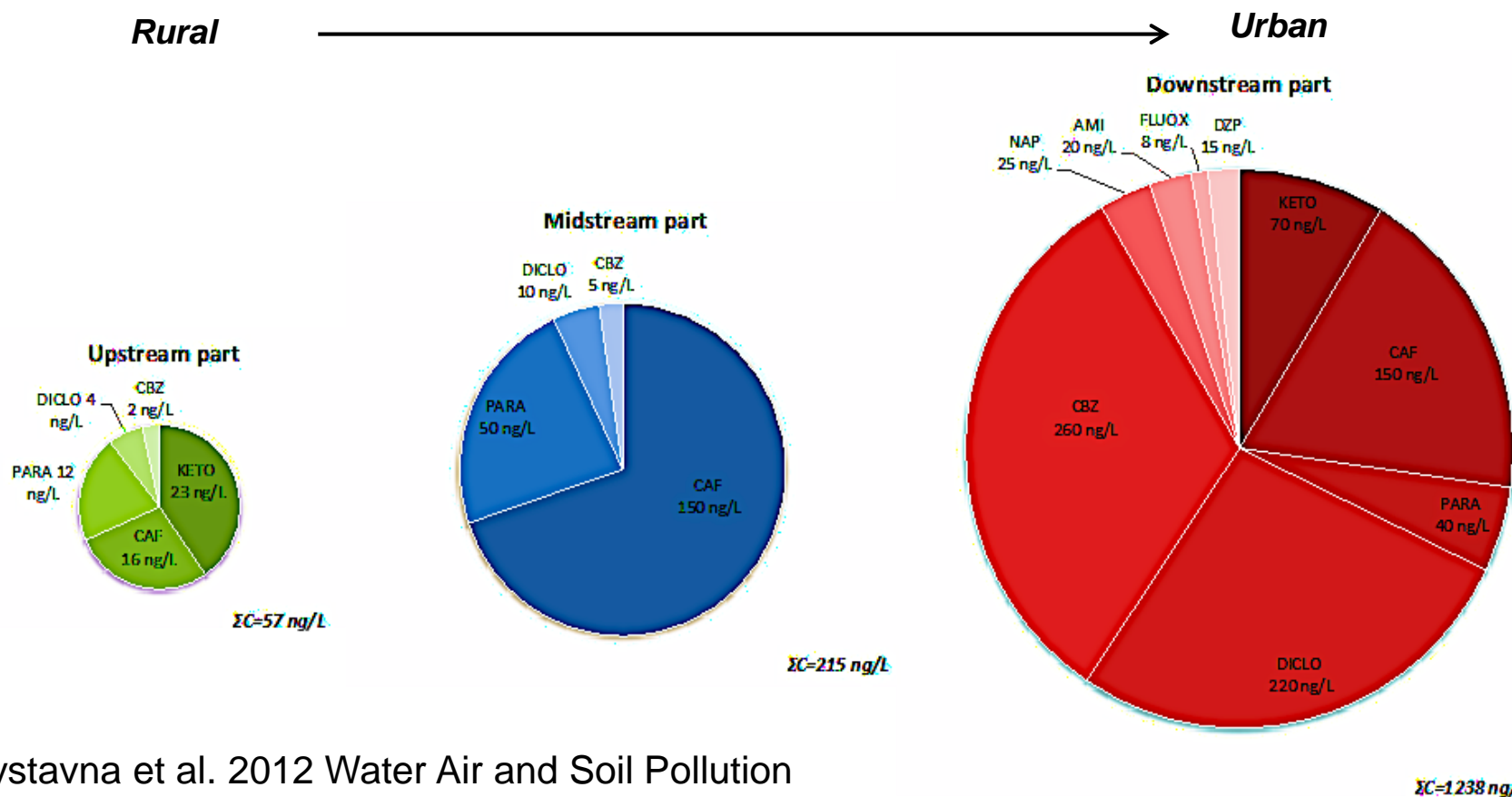
Simulation and replacement of natural hormones

- Disturbance of endocrine system
- Reduction of the fertility
- Formation of abnormalities

Occurrence in the environment



Urban area is more responsible for the occurrence of priority substances and emerging pollutants

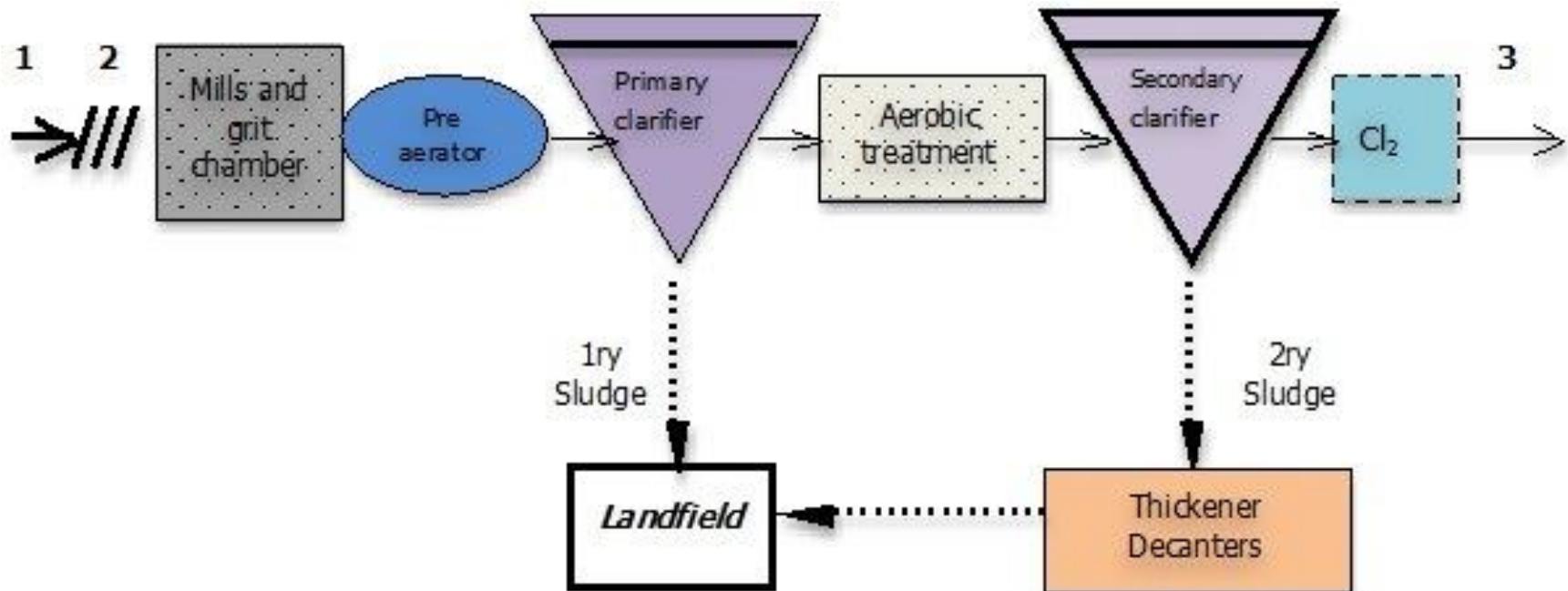


Vystavna et al. 2012 Water Air and Soil Pollution

Vystavna et al. 2013 Environmental Monitoring and Assessment

Vystavna et al. 2018 Science of the Total Environment

Is conventional wastewater treatment plant eliminate emerging compounds?

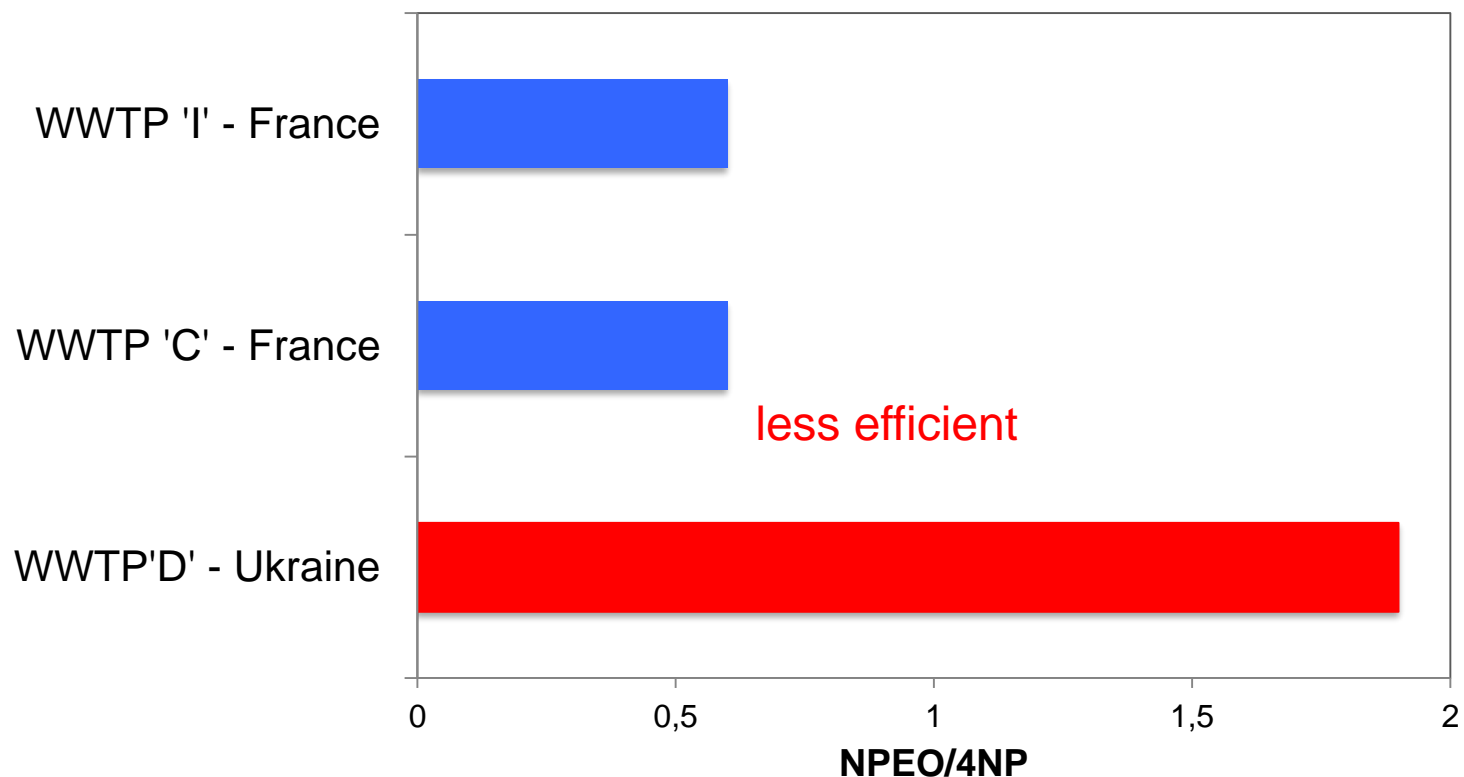


Wastewater treatment processes are highly variable between countries

The efficiency of the biological treatment at the WWTPs.

Σ NPEO – by product of anaerobic degradation

4NP – persistent end product of the degradation



Advanced wastewater treatment



REVISED OSMOS – 99%



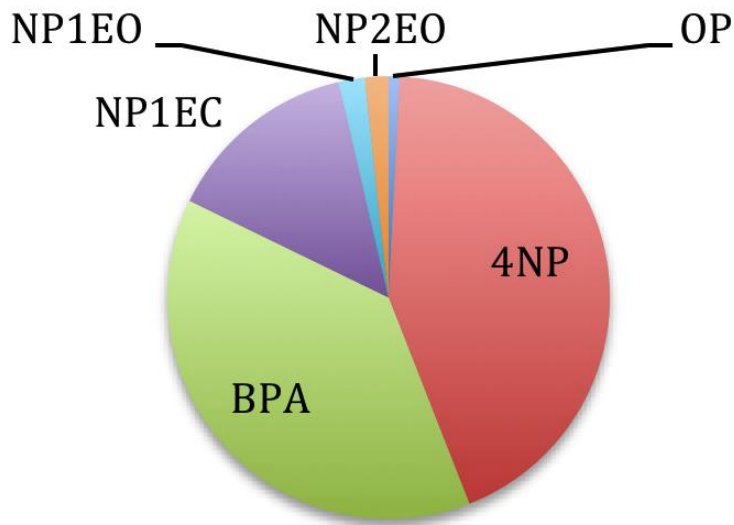
ACTIVATED CARBON– 90%

- **expensive**
- **for limited volume of water**
- **problem of recycling of by-products from treatment processes**

Regulation and consumption of priority substances and emerging compounds can be highly different between countries

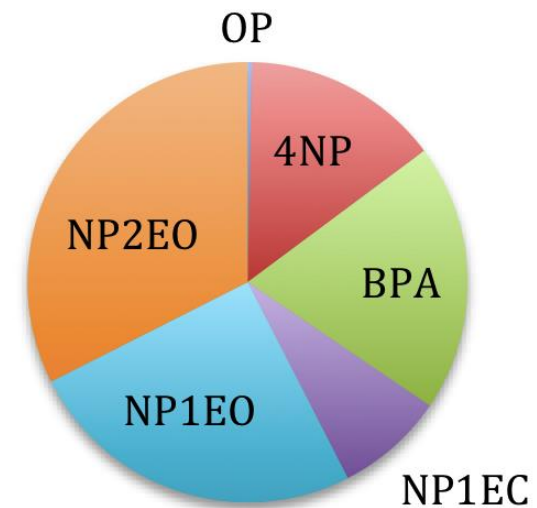
Example: *Alkylphenols*

Bordeaux, France, mg/inh/day



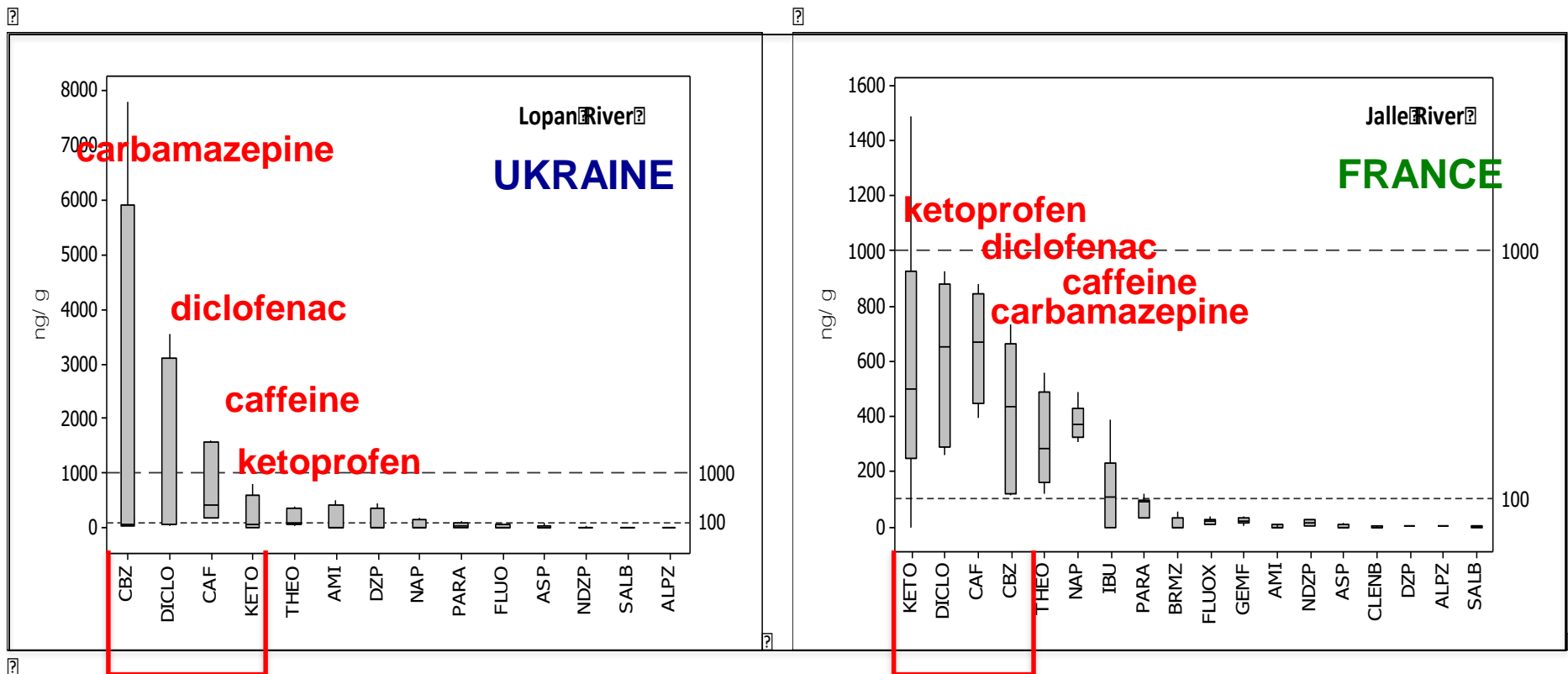
Industrial effluents

Kharkiv, Ukraine, mg/inh/day



Municipal effluents

Occurrence of pharmaceuticals in rivers of EU and Ukraine



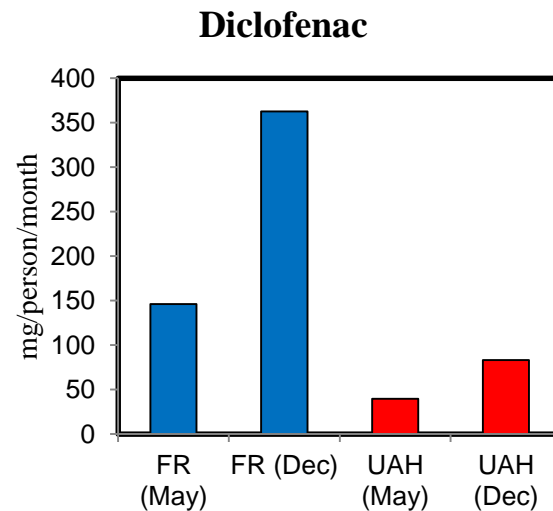
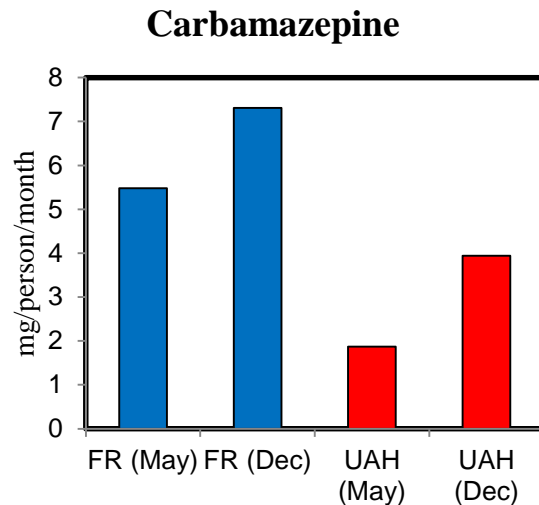
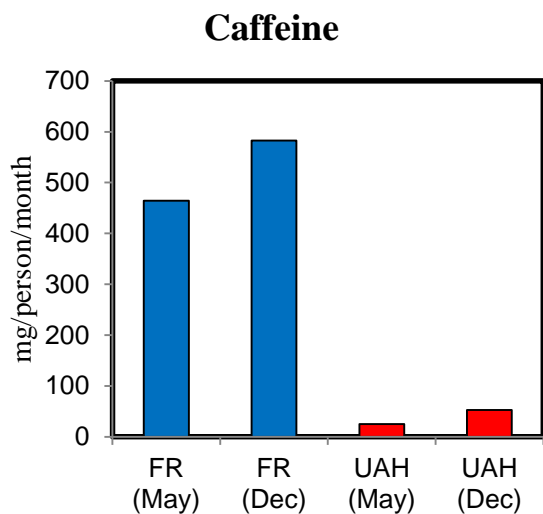
Diclofenac is in the EU Watch List

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Consumption of pharmaceuticals in EU and Ukraine



Pharmaceuticals	Fact (France, 2006) g/person/year	Calculated (France, 2009) g/person/year
Carbamazepine	0.3	0.1
Diclofenac	4.3	0.3

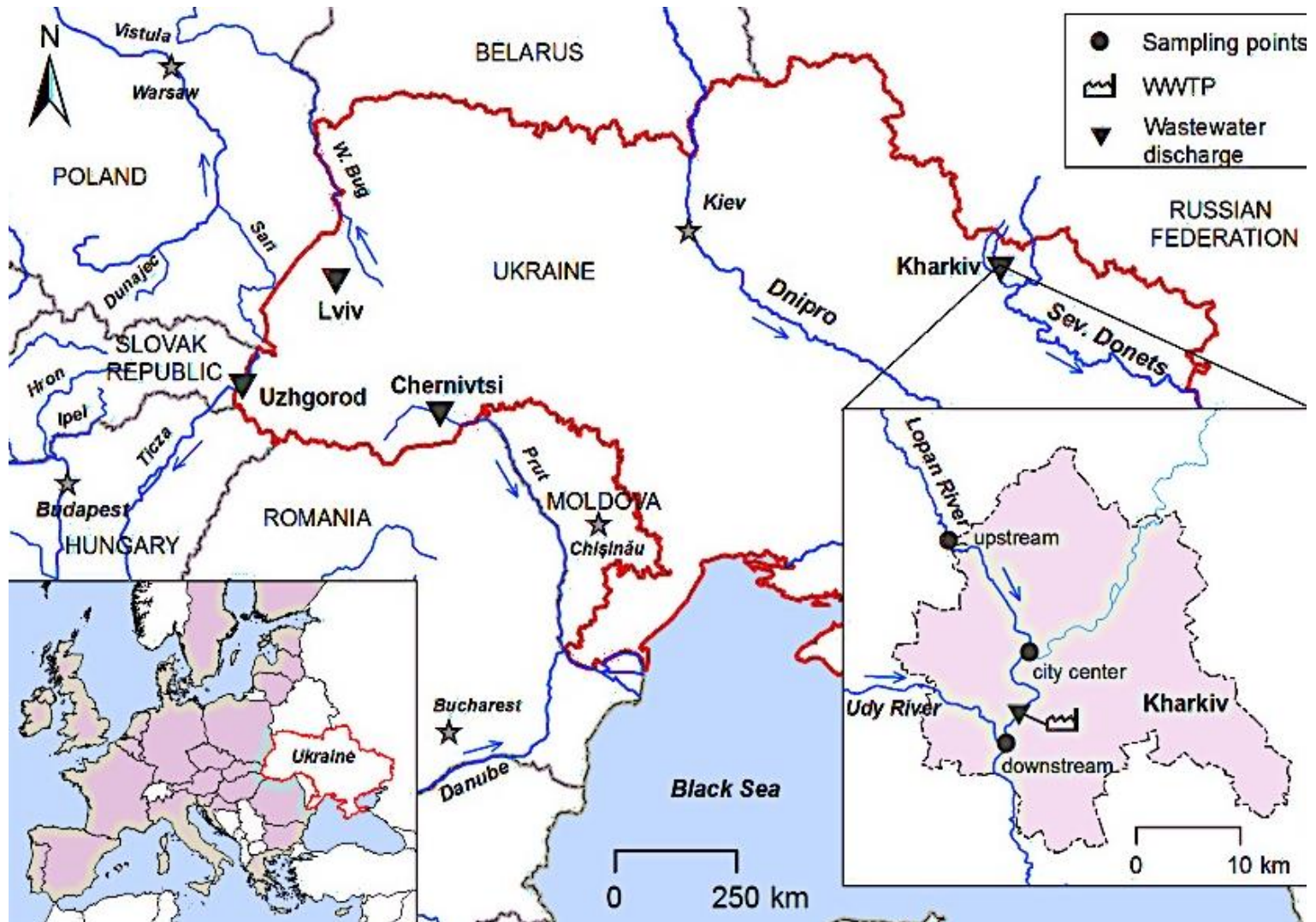
Regulated substances in EU and Ukraine

Substance	European Union		Ukraine EQS
	AA-EQS	MAC-EQS	
Pb	1,200	14,000	100,000
Naphthalene	2,000	130,000	n/a
Anthracene	100	100	n/a
Fluoranthene	6.3	120	n/a
Benzo(a)pyrene	0.17	270	n/a
Nonylphenols	300	2,000	n/a
Octylphenols	100	n/a	n/a
Diclofenac	100 ¹	n/a	n/a
PCBs	n/a		n/a
PAHs	n/a		n/a

Vystavna et al. 2018 Water International

Vystavna et al. 2018 Science of the Total Environment

Transboundary EU/Ukraine water basins



Annual mass loading from Ukraine into EU transboundary rivers

- Trace metals (Pb, Cd, Ni)
1.2 tones

- Diclofenac 0.7 tones

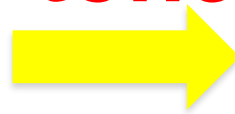
- Nonylphenols 0.4 tones

other contaminants:

PCBs

PAHs

3 tones



Danube River

Western Bug River

Transboundary groundwater contamination

Riluzole

Dihydrocodeine

Sulfathiazole

Papaverine

Pentedrone
(DEET)

Aripiprazole

Pizotifen

Pilocarpine

Caffeine

Nikethamide

Clanoclavine

Pergolide

Phenazone

Alternariol

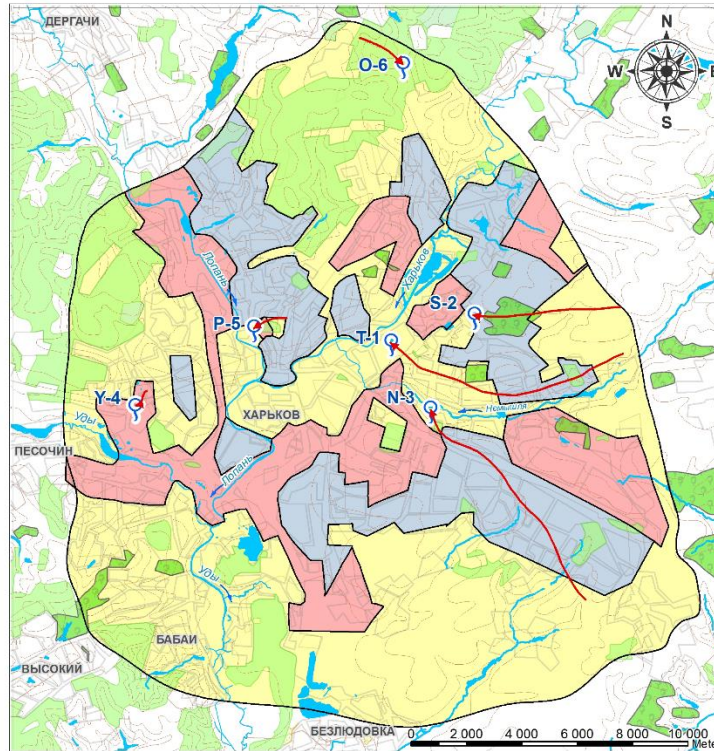


Рис.1 - Градации величины дополнительного питания грунтовых вод в г. Харькове и средние линии тока подземных вод, питающих родники

Условные обозначения

N-3 - местоположение родника, линия тока подземных вод и зоны формирования стока родников

Площадь города с дополнительным питанием в грунтовые воды, 10^4 м³/сутки:

1...5 5...8 >8

■ - лесные массивы

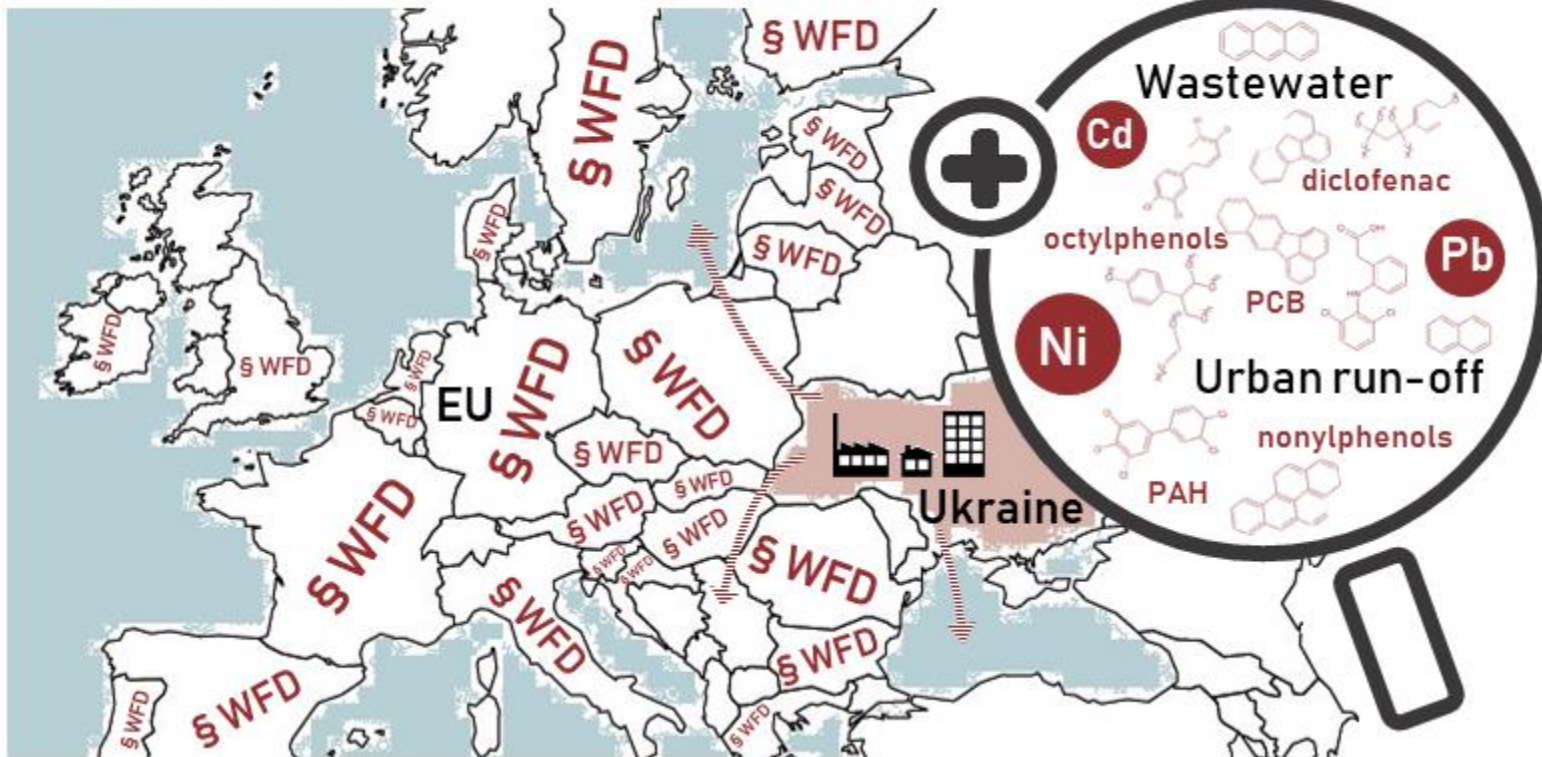
Родники:

T-1 Tyurynsky
S-2 Saltovsky-1
N-3 Nemyshlya
Y-4 Yunost
P-5 Panteleymonovsky
O-6 Ocheretyanka

Highlights

- **Increasing standards** of living, economic changes and human population growth lead to the rising of chemicals use
- Occurrence of pollutants is closely linked to the regional **socio-economic profile**, to **policy and regulation**
- Coming into water, emerging pollutants **pose high environmental and health risks**
- Current environmental protection measures have **limited efficiency to eliminate** these contaminants from the aquatic environment
- Water policy and management tools should be **the main solution** to reduce pollutants which enter the environment in multiple ways
- In developing countries emerging pollutants control and regulation are **great challenges** in terms of lack of financing, qualified experienced specialists and access to the updated environmental data

Mass loading into transboundary rivers ?



Think about your neighbors!



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