

# Global Relevance of Pharmaceuticals in the Environment: Emerging Policy Issue under UNEP-SAICM ?

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*(Please scroll down in this document for presentation slides.)*

Pharmaceuticals are known to occur widely in the aquatic environment of industrialized countries. In developing countries, more information on the occurrence of pharmaceuticals in the environment has become available in recent years, but a concise picture on the prevailing concentrations and potential effects on human and ecosystem health in these countries is still elusive. The International Society of Doctors for the Environment has recently suggested the topic “Environmentally Persistent Pharmaceutical Pollutants” for nomination as an emerging issue under the Strategic Approach on International Chemicals Management (SAICM) of the United Nations Environmental Programme (UNEP). The Open-ended Working Group OEWG 1 encouraged further development of the proposal under SAICM following ICCM3 held in Nairobi in September 2012.

The German Federal Environment Agency (UBA) has thus initiated a research project to define the state of knowledge on the global relevance of pharmaceuticals in the environment. The objectives of the project are to i) demonstrate the global occurrence of human and veterinary pharmaceuticals within all five UN regions, ii) compare regional pharmaceutical consumption data and future trends, iii) assess the relevance of emission pathways (production, use, disposal) on a global scale, iv) assess the role of infrastructure, population, pharmaceutical availability, agricultural practice, etc. on emissions of pharmaceuticals into the environment, v) present databases and maps to illustrate the global relevance of pharmaceuticals in the environment as an emerging policy issue and to prepare possible activities for inclusion into the global plan for action. Further information on the project is also available through the project website on [www.pharmaceuticals-in-the-environment.org](http://www.pharmaceuticals-in-the-environment.org).

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## FP7 PHARMAS

Science-Policy Event: Current scientific developments and policy responses

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(German Federal Environment Agency - UBA)

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■ **Environmental Persistent Pharmaceuticals Pollutants (EPPP) was suggested by the *International Society of Doctors for the Environment (ISDE)* in 2010 for nomination as an **emerging policy issue** under SAICM:**

- EPPP did not meet the criteria, but encouraged further consideration following ICCM3 held in Sept. 2012
- German Federal Environment Agency (UBA) initiated research project to determine the **state of knowledge on global relevance of EPPP**.

■ **In industrialized countries:**

- Pharmaceuticals occur widely in European surface waters
- But no concise picture on prevailing concentrations and potential effects

■ **In developing and emerging countries?**

# Project Tasks

1. Compile MECs of **human and veterinary pharmaceuticals** from all five UN regional groups.
2. Compare regional **consumption data** and future trends.
3. Assess the relevance of different **emission pathways** (production, use, disposal).
4. Assess the **role of infrastructure, population, pharmaceutical availability, agricultural practice, etc.** on the emissions of pharmaceuticals into the environment.
5. **Produce databases and maps** that could illustrate the global relevance of pharmaceuticals in the environment as an emerging issue.
6. Prepare possible activities for inclusion into a **global plan for action**.

# Literature Compilation

- **1016 publications** reporting MECs of pharmaceuticals in various countries (plus 139 review articles)
- **Search Strategy:**
  - Database search
  - NORMAN, KNAPPE, FATE-SEES
  - Contacting of stakeholders
- **Types of publication**
  - Mostly English-language scientific paper
  - Governmental reports
  - Some German-, Chinese-, French-, Russian-, Slovenian-, Portuguese-, Dutch-, Swedish- and Spanish-language publications evaluated



Umwelt  
Bundesamt  
Für Mensch und Umwelt

<http://www.umweltdaten.de/publikationen/fpdf-l/4188.pdf>

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Hughes et al. (2012): Environ. Sci. Technol. 47, 661-677



# MEC Database (measured environmental concentrations)

■ 123,761 MEC entries from 1016 publications

Count	Matrix_English	Count	Matrix_English
49.330	1.891 Sewage urban (untreated)	283 Sediment - unspecific	
	729 Sewage industrial (untreated)	1.247 Sediment - River/Stream	
	2.889 Sewage hospital (untreated)	612 Sediment - Lake	
	351 Sewage hospital (treated)	55 Sediment - Sea or Ocean	
	13.219 WWTP inflow (untreated)	184 Sediment - Aquaculture	
	27.579 WWTP effluent (treated)	155 Sediment - Estuary	
	2.672 WWTP sludge	9 Suspended particulate matter - unspecific	
67.987	3.245 Surface Water - unspecific	5 Suspended particulate matter - Estuary	
	50.686 Surface Water - River/Stream	146 Suspended particulate matter - Sewage	
	1.711 Surface Water - Lake	12 Suspended particulate matter - Sea or Ocean	
	1.420 Surface Water - Sea or Ocean	362 Suspended particulate matter - River/Stream	
	467 Surface Water - Aquaculture		
	743 Surface Water - Estuary	15 Rain	
	485 Riverbank filtration	1.295 Soil	
	3.304 Groundwater	372 Soil Water	
	1.713 Well Water (untreated)	999 Manure - liquid	
	382 Tap water	580 Manure - dung	
	3.831 Drinking Water	18 Dust	
		95 Unknown	

# Data Analyses

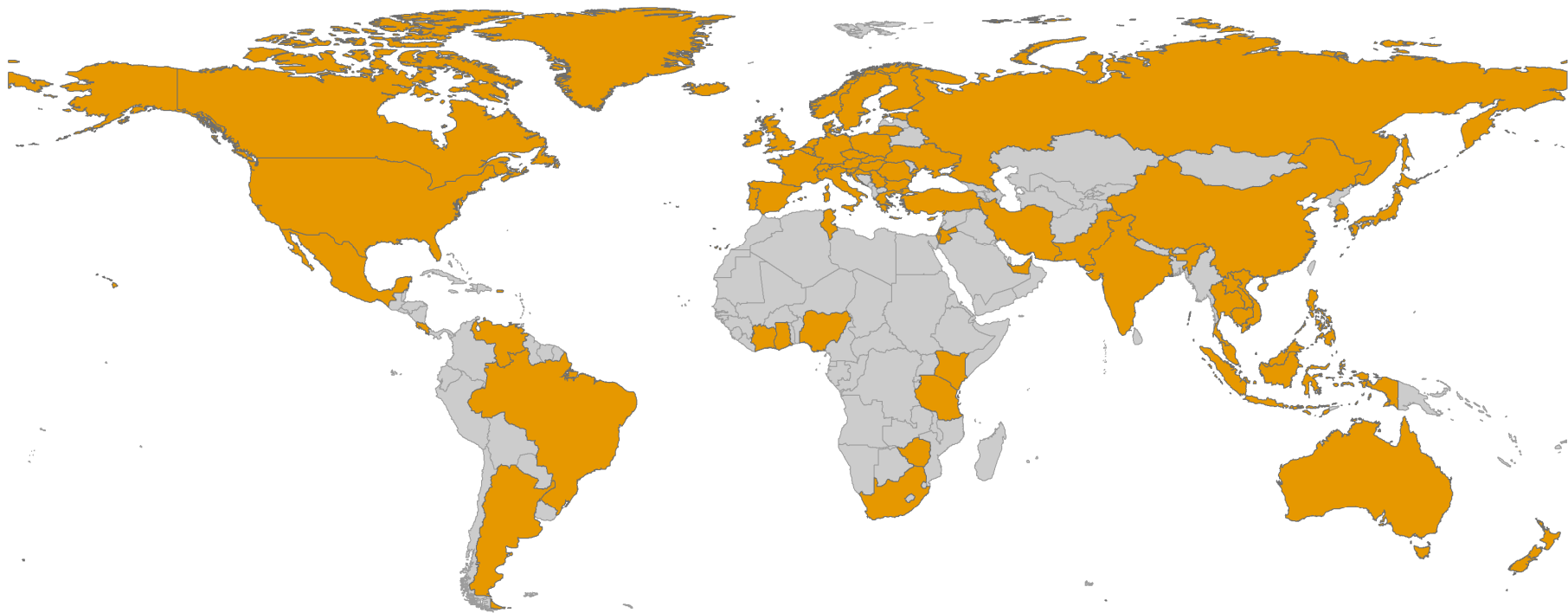
## Questions to be answered by the MEC Database:

- On a global scale, in which countries have pharmaceuticals been found in the environment ?
- How many and what kind of pharmaceuticals have been found ?
- Are the same pharmaceuticals detected in each UN group?
- What is the source of the pharmaceuticals found ?
- At which concentrations are pharmaceuticals found in the environment?
- Can pharmaceuticals have ecotoxicological effects at these concentrations?



## Data Analyses

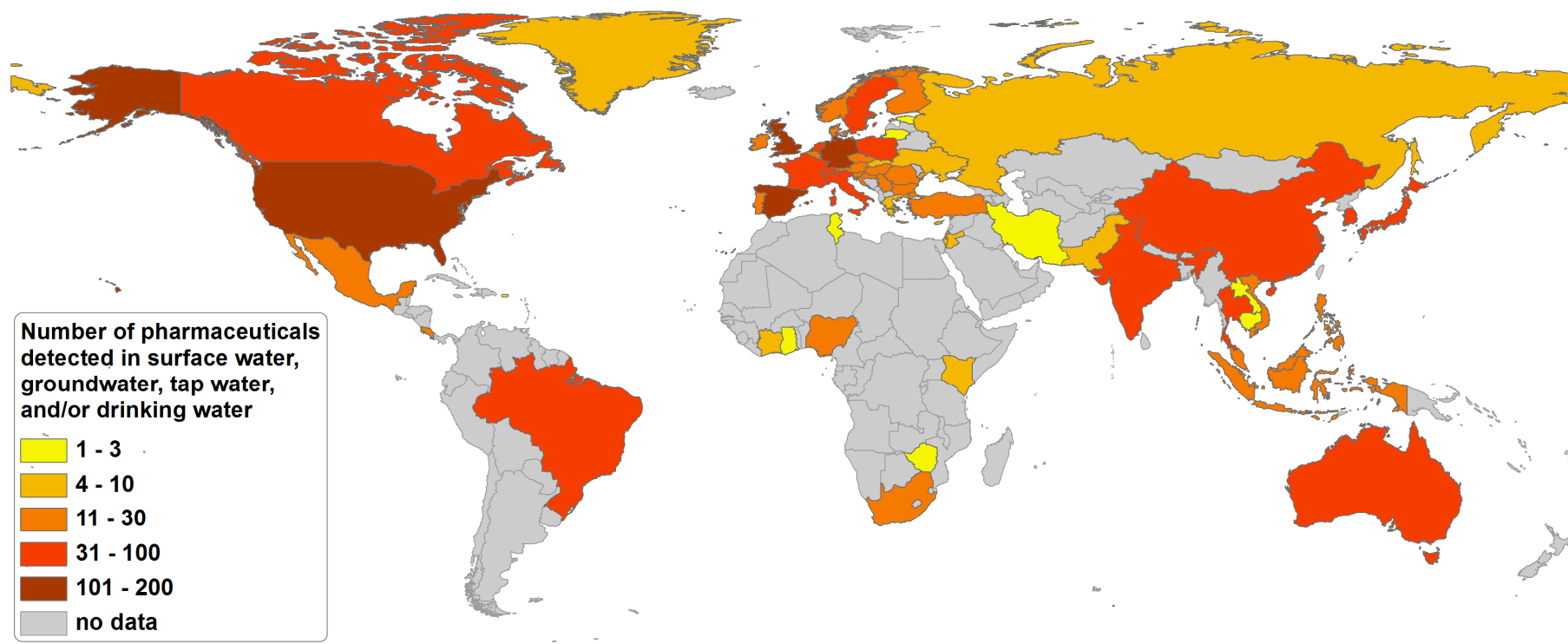
- **In  $\geq 71$  countries (covering all 5 UN regional groups), pharmaceuticals have been detected in the environment.**  
(at least one MEC in one matrix > detection limit)



# Data Analyses

How many pharmaceuticals have been found in each UN regional group?

- In each UN regional group,  
 $\geq 38$  different pharmaceuticals have been found in  
surface water / groundwater / drinking water / tap water.



# Data Analyses

Are the same pharmaceuticals detected in each UN regional group?

**126 (205)  
in EEC**

**249 (313)  
in Asia-Pacific**

**574 (646)  
in WEOC**

**55 (84)  
in GRULAC**

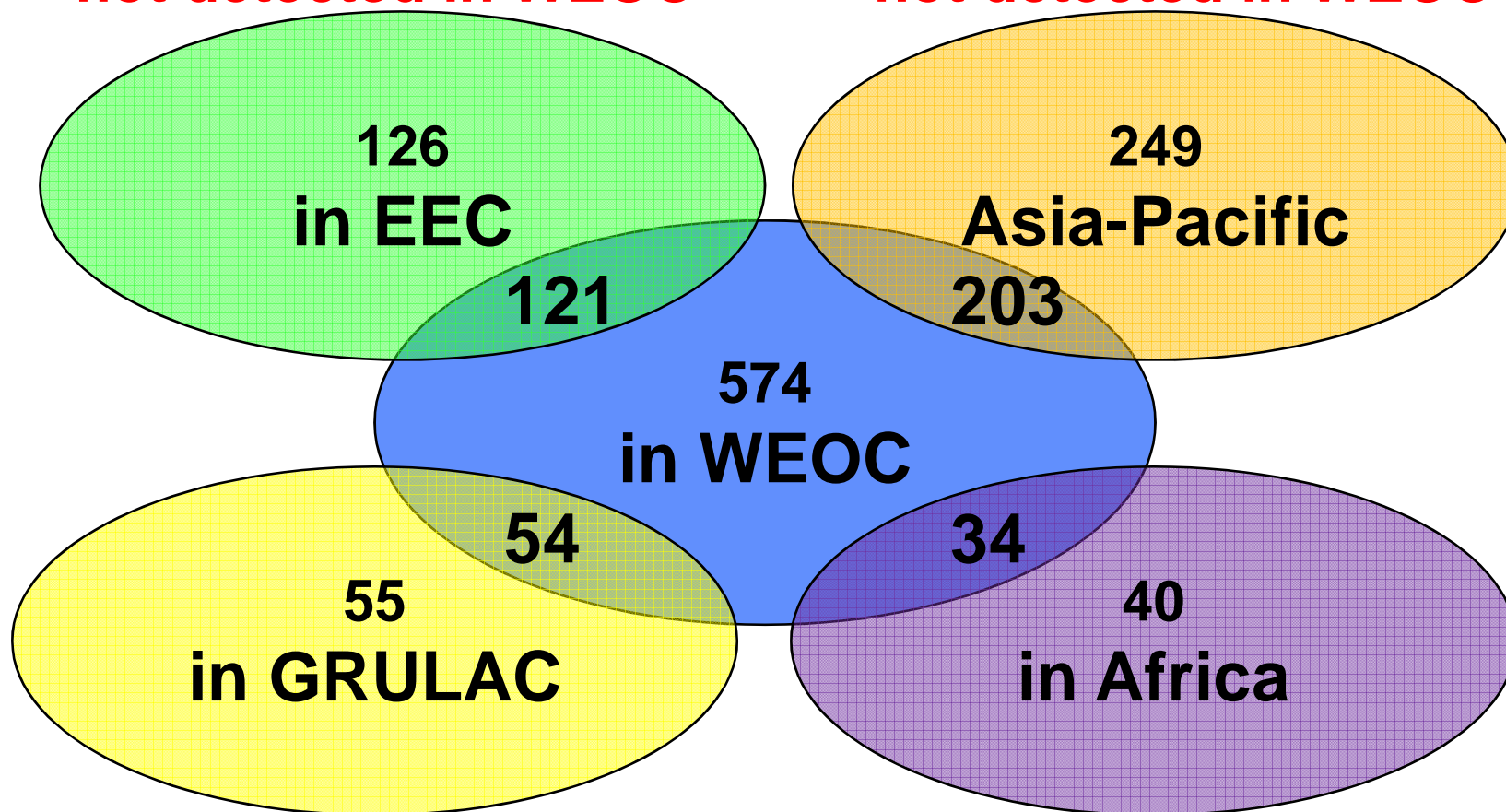
**40 (59)  
in Africa**

# Data Analyses

Are the same pharmaceuticals detected in each UN regional group?

5 not measured/  
not detected in WEOC

46 not measured/  
not detected in WEOC



1 not measured/  
not detected in WEOC

6 not measured/  
not detected in WEOC



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# Data Analyses

Are the same pharmaceuticals detected in each UN regional group?

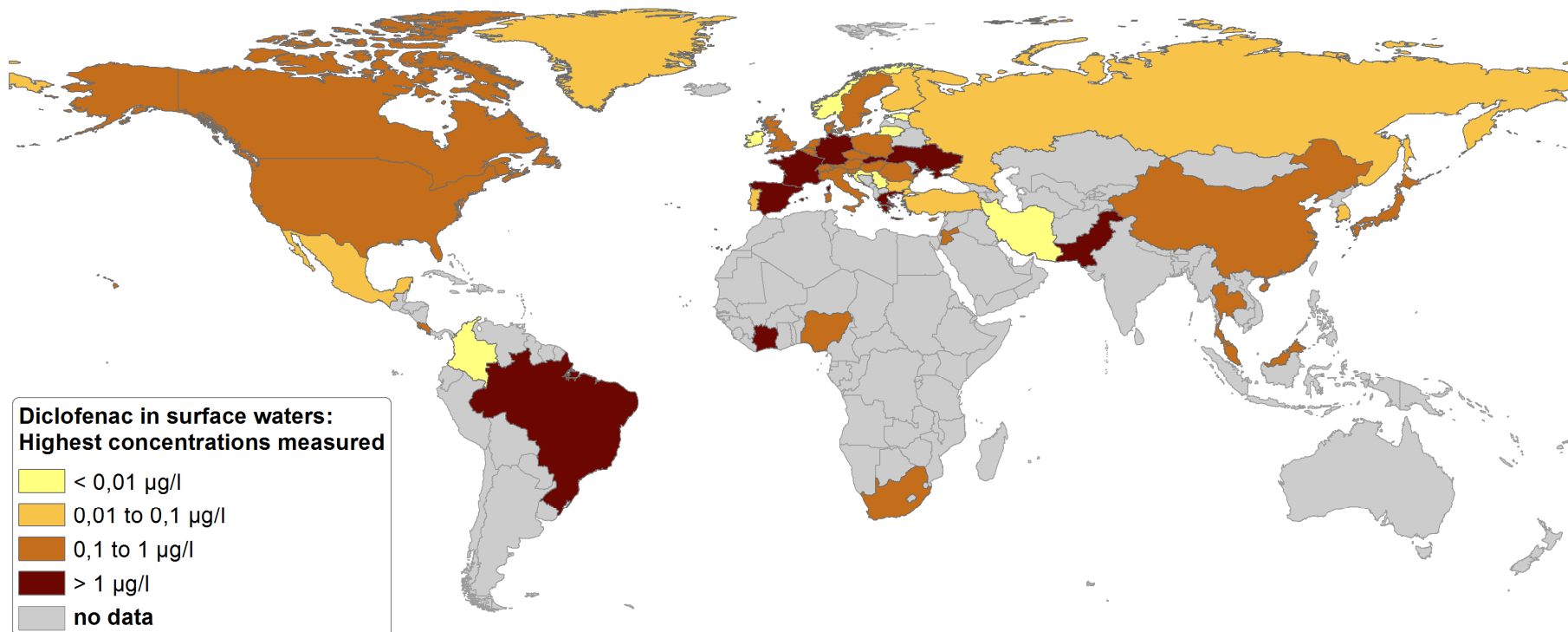
- 16 pharmaceuticals were found in surface water / groundwater / drinking water / tap water in each of the five UN regional groups.

Name	Therapy Group	Number of Countries with Positive Detection in Surface Water, Groundwater, Drinking Water					
		African Group	Asia Pacific Group	EEG	GRULAC	WEOG	global
Diclofenac	Analgesics	3	8	13	3	23	50
Carbamazepine	Antiepileptic drugs	3	6	13	2	24	48
Ibuprofen	Analgesics	3	8	10	2	24	47
Sulfamethoxazole	Antibiotics	5	9	10	2	21	47
Naproxen	Analgesics	2	8	10	2	23	45
Estrone	Estrogen	1	10	6	2	16	35
17-beta-Estradiol	Estrogen	2	9	4	2	17	34
17-alpha-Ethinylestradiol	Estrogen	1	8	3	2	17	31
Trimethoprim	Antibiotics	2	9	3	2	13	29
Paracetamol	Analgesics	1	6	4	3	15	29
Clofibric acid	Lipid-lowering drugs	1	3	5	2	12	23
Ciprofloxacin	Antibiotics	1	5	1	2	11	20
Ofloxacin	Antibiotics	1	4	1	1	9	16
Estriol	Estrogen	1	1	2	1	10	15
Norfloxacin	Antibiotics	1	4	1	2	7	15
Acetylsalicylic acid	Antibiotics	1	4	1	2	7	15

# Data Analyses

At which concentration are pharmaceuticals found in the environment?

## ■ Maximum Diclofenac concentration in surface waters

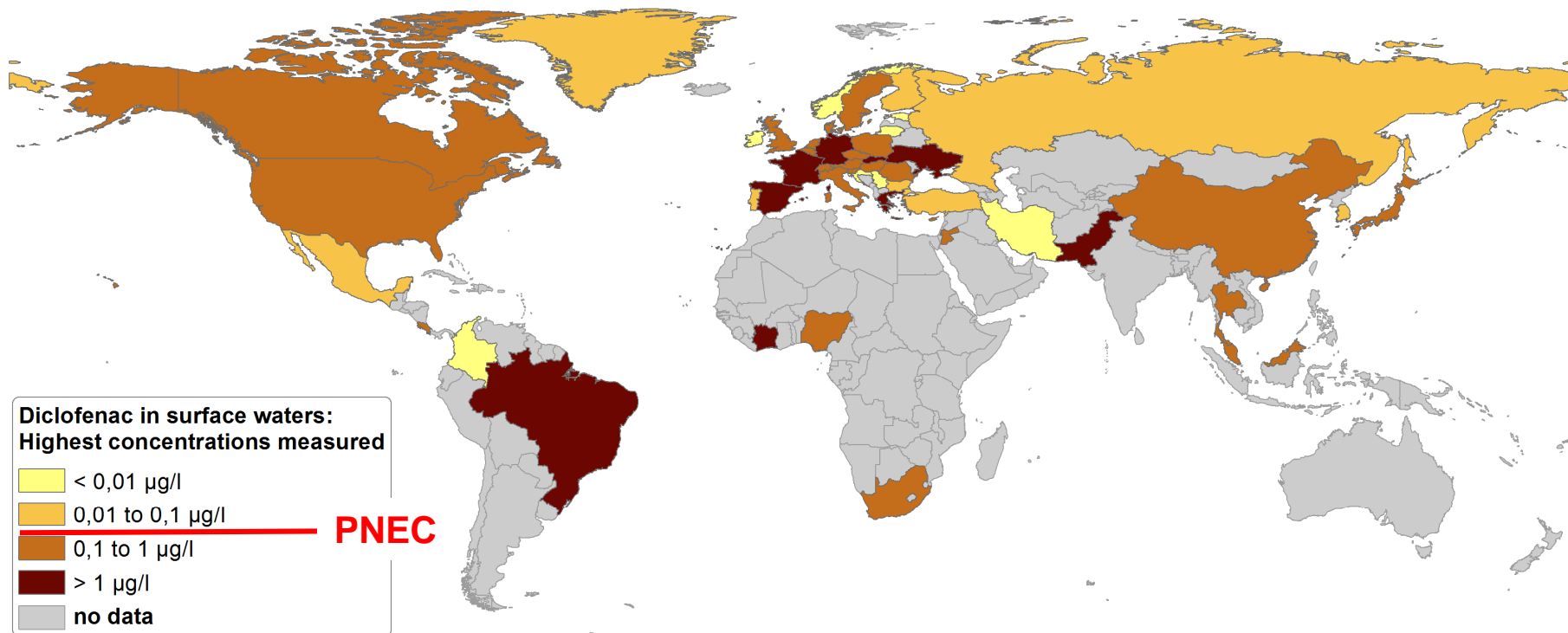




# Data Analyses

Can pharmaceuticals have ecotoxicological effects at these concentrations?

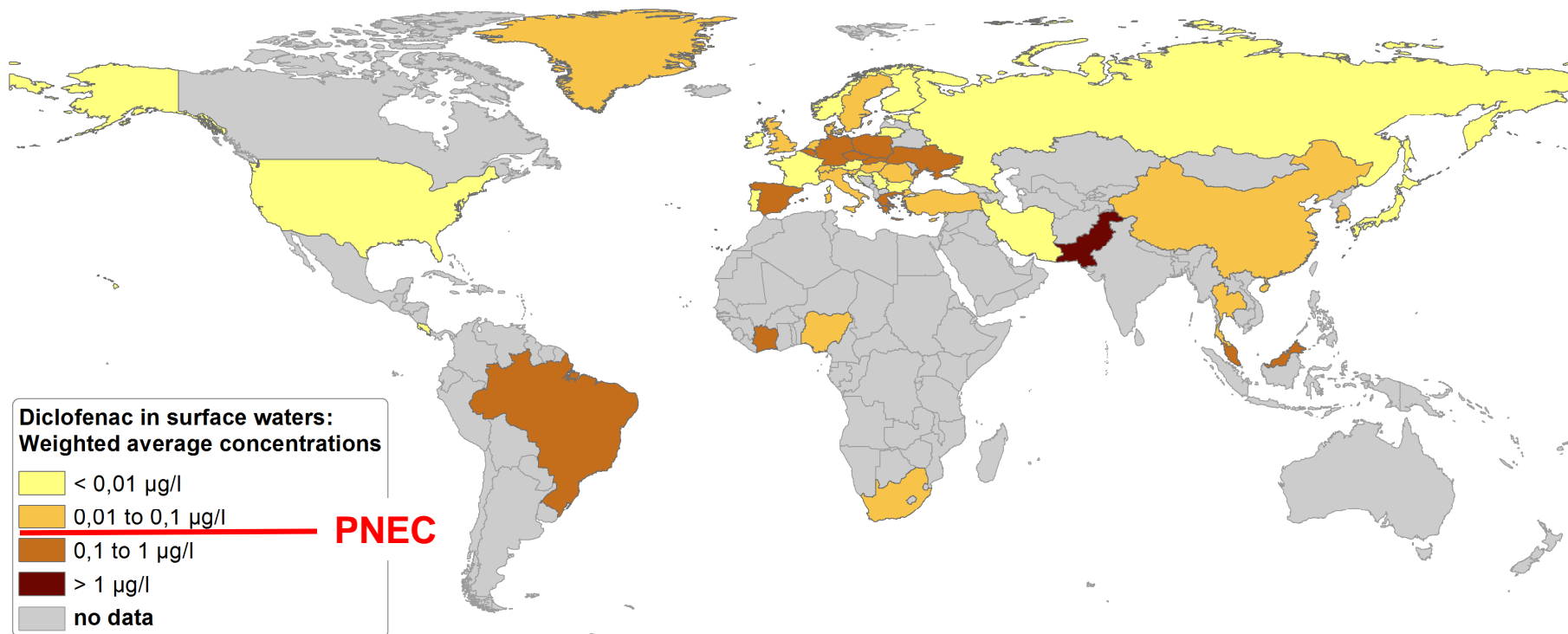
- Maximum Diclofenac concentration in surface waters in comparison to Predicted No Effect Conc. (PNEC)



# Data Analyses

Can pharmaceuticals have ecotoxicological effects at these concentrations?

## ■ Average Diclofenac concentration in surface waters in comparison to Predicted No Effect Conc. (PNEC)



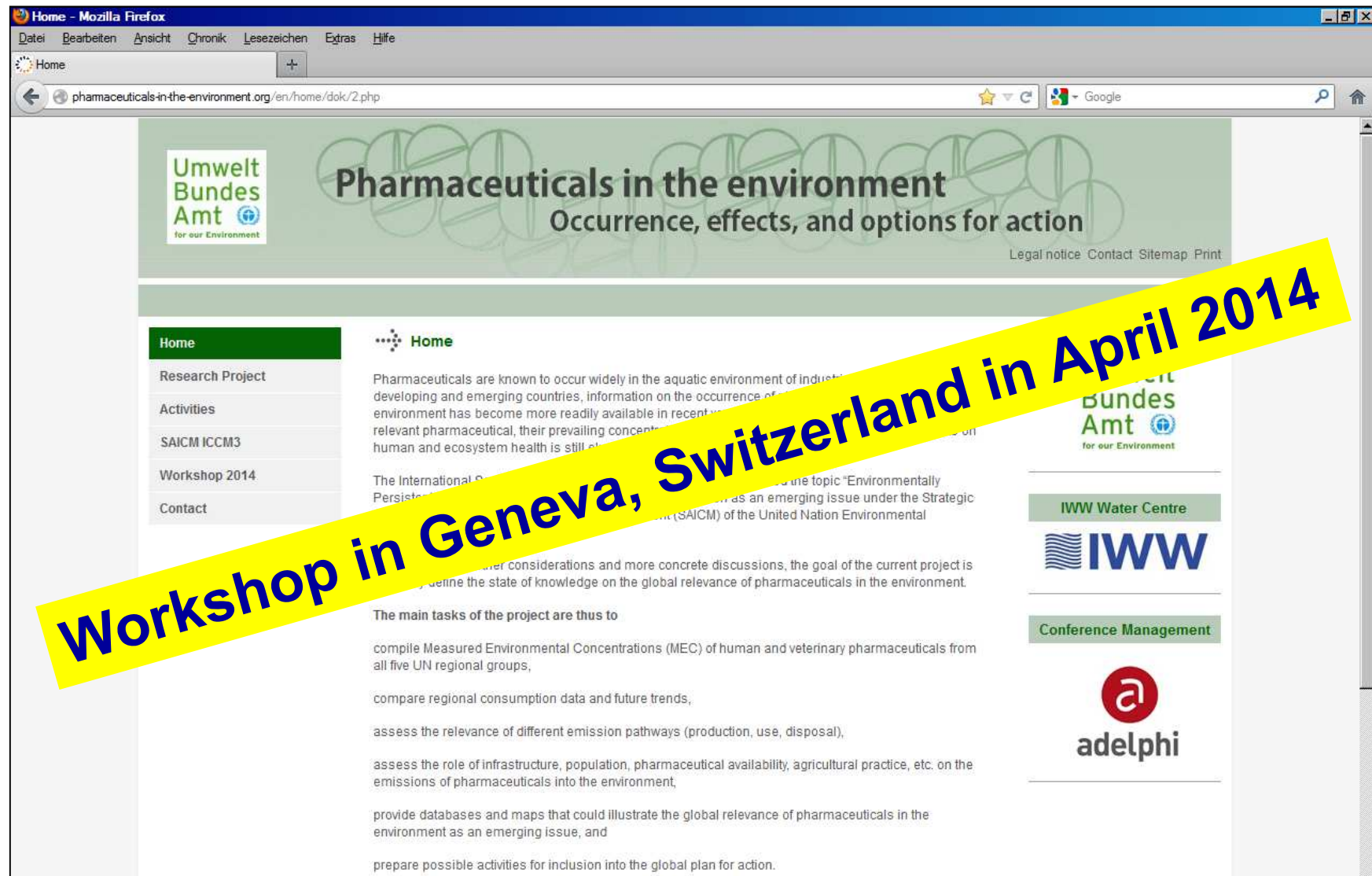
# Conclusions

- Pharmaceuticals **occur globally** in the environment, many at **ecotoxicologically relevant concentrations**.  
(not just in industrialized countries):
  - Detected in  $\geq 71$  countries covering all 5 UN regional groups
  - While there is **order-of-magnitude** more data available in WEOG, MECs are also **available in emerging and developing countries** showing positive detection of various pharmaceuticals, even in concentrations **exceeding PNEC values**.
- **Partial overlap** in the pharmaceuticals detected globally
- Urban wastewater discharge is the dominant **emission pathway** globally, while discharge from production, agricultural uses and aquaculture can be important locally
- Publicly available **data on production/consumption** not sufficient for a global analysis



- The decision of the OEWG (I/4B) on New **Emerging Policy Issues** encouraged the proponents of the proposal on environmentally persistent pollutants in the environment to **develop further the proposal**.
  
- Initiate discussion on **possible activities** for inclusion into a global plan for action.

# www.pharmaceuticals-in-the-environment.org



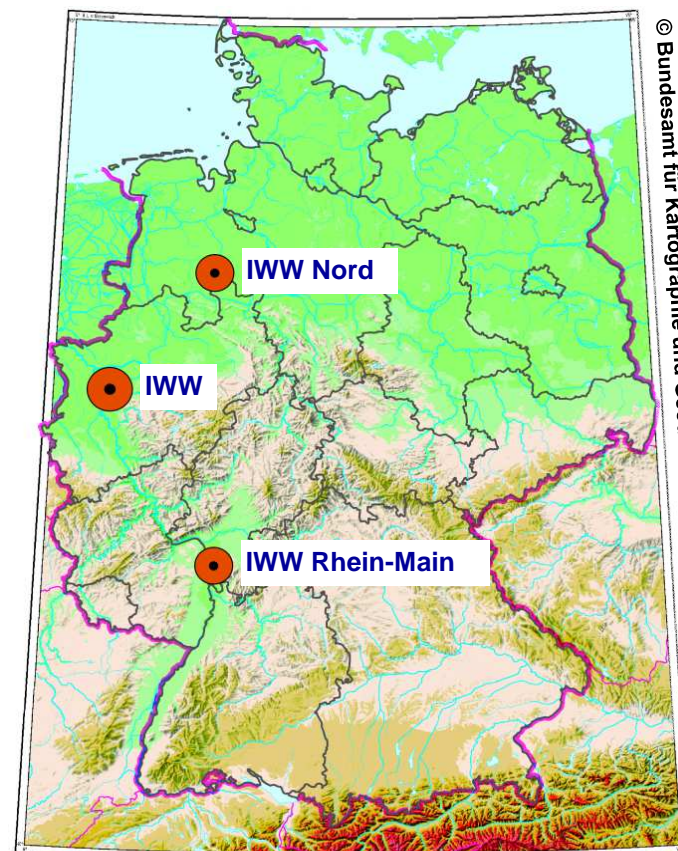




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