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Emerging pollutants research needs in the future

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Water Challenges for a Changing World
Joint Programming Initiative

Emerging pollutants (EP) research needs in the future

- Which CECs / EPs do we consider currently?
- What does research on current EPs has in common?
- What is missing in current research on EPs?
- What to do in future and how to do this?

Which EPs do we consider currently?

- What is a CEC / EP?
- Who knows; but we mean:
  - Organic micropollutants & derivates
  - Engineered nanoparticles
  - Synthetic materials (plastic & microplastic)
  - Antibiotic resistance
- Systematic EPs research on a broader scale started at about 2000 after the WFD was set in place

What does research on different EPs has in common?

- First occupation with the specific EP investigated today usually can be found several years back in scientific literature before getting “mainstream”
  - Usually from other research fields out of the water sector
  - Usually problem driven
- Start of broader considerations by monitoring studies by groups that had analytical possibilities
- Further development of analytical methods with lower LOD / LOQ and broader availability of methods

What does research on different EPs has in common?

- All compartments of the urban water cycle (UWC) were analyzed for more and more representatives of EP groups at lower and lower LOD / LOQ
  - Raw water for water supply and drinking water
  - Wastewater and wastewater treatment plants
  - Surface waters
  - Ground water
  - Compartments linked to UWC (soil; irrigation; stormwater; …)
- Simplified: everything is found everywhere

⇨ congratulations: you just proved the 2nd law of thermodynamics

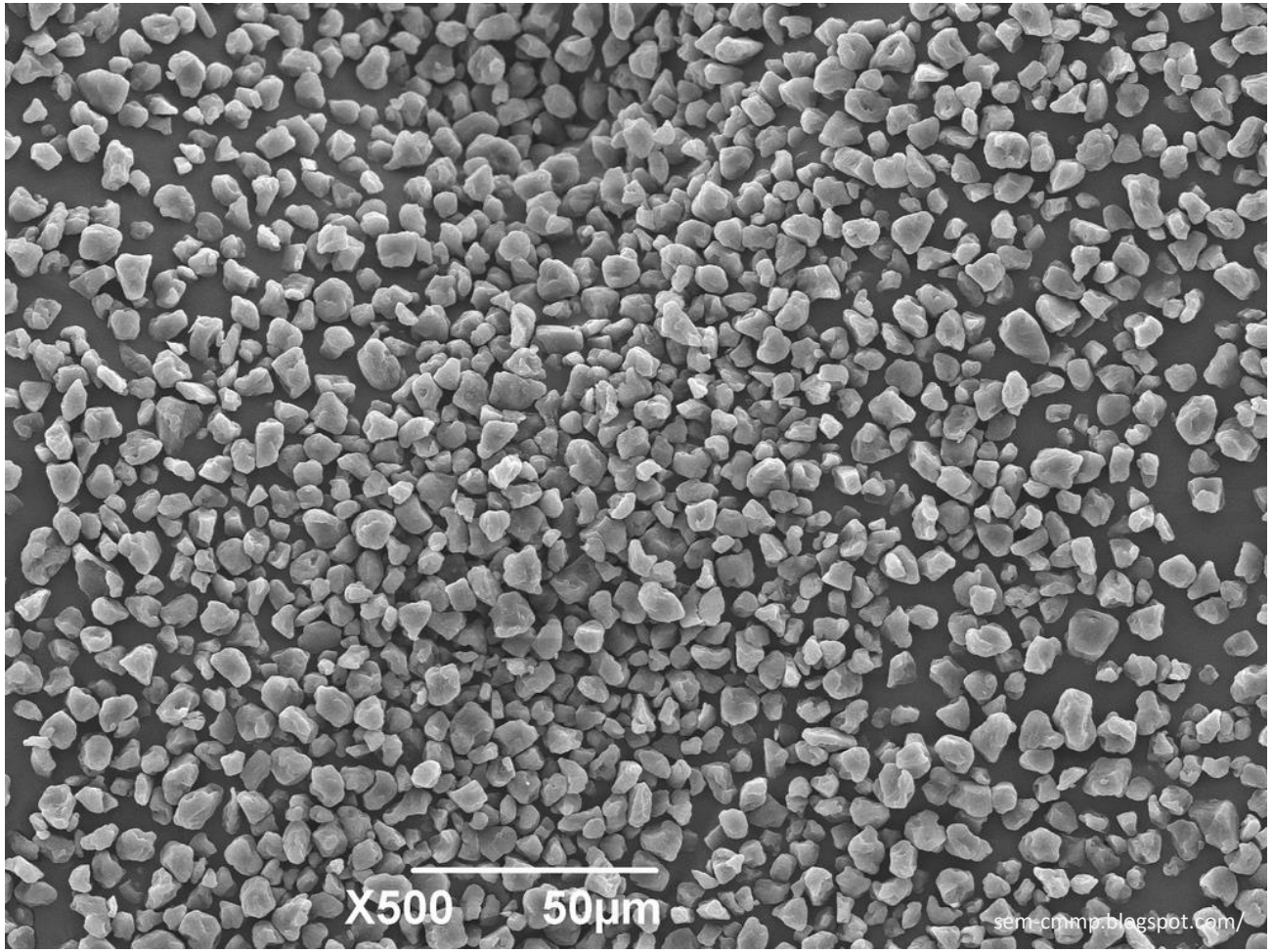
What does research on different EPs has in common?

- Afterwards it always is getting tricky:
  - What does a certain value of a specific substance mean?
  - Is the pure "existence" of an EP a problem?
  - How to measure / quantify the problem / hazard?
  - What risk is linked to the hazard – to humans; to environm.?
  - Where do we want to got?
  - How to communicate uncertainties and risks?
  - What are the main pathways / sinks / processes linked?
  - What technical / political measures are required?

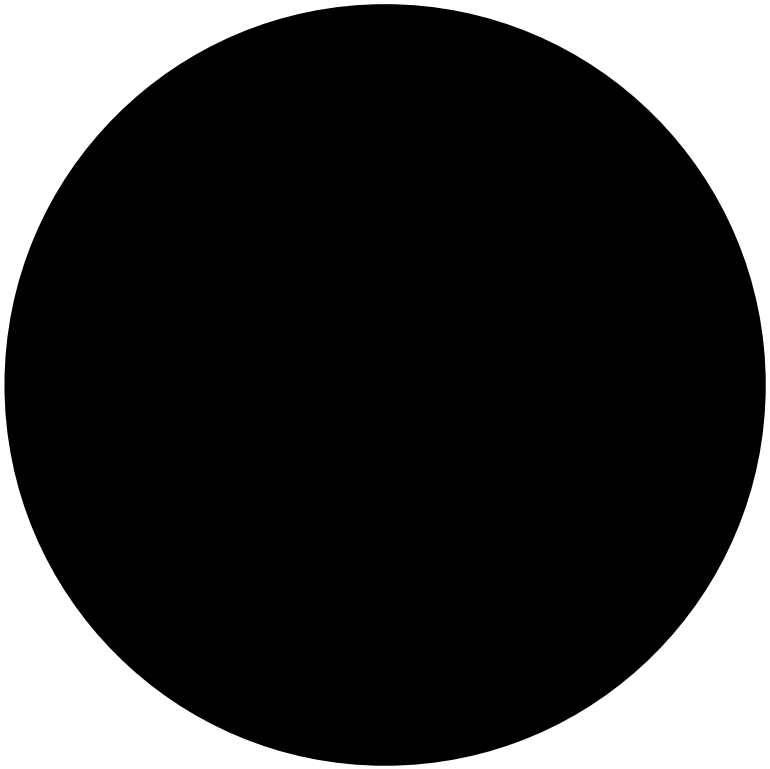
⇨ Further research needed (Let's try science!)

What is it?

Zooming in several steps



Zooming out one step



Zooming out several steps

This one?

https://www.etsy.com

This one?

https://www.biobilgi.com/pandoranin-kutusu-nedir-ne-demek/

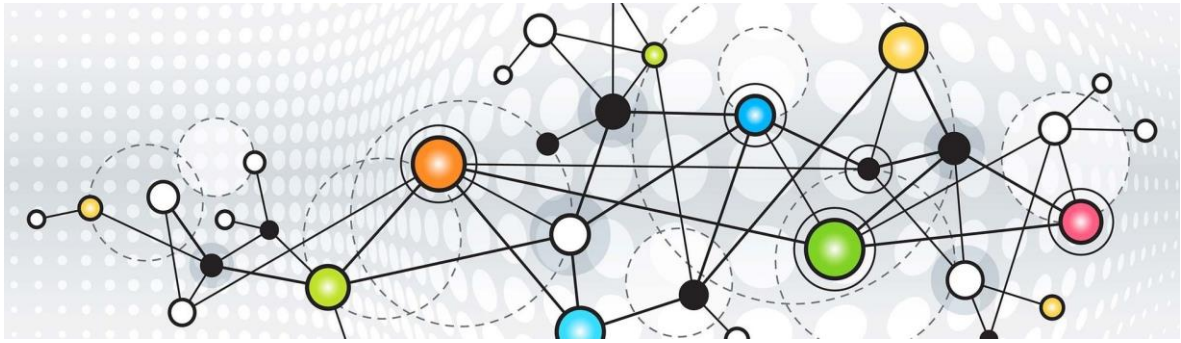
What does research on different EPs has in common?

- Knowledge on details exponentially is increasing
- Less and less people understand the leading edge approaches and can critically discuss them
- Reproducibility gets difficult
- We have to “belief” instead of “knowing”
  (not only politicians and env. Managers, but fellow researchers too.)
- As things get more and more complicated and complex:
  - lack of system understanding
  - Not recognizing the big picture

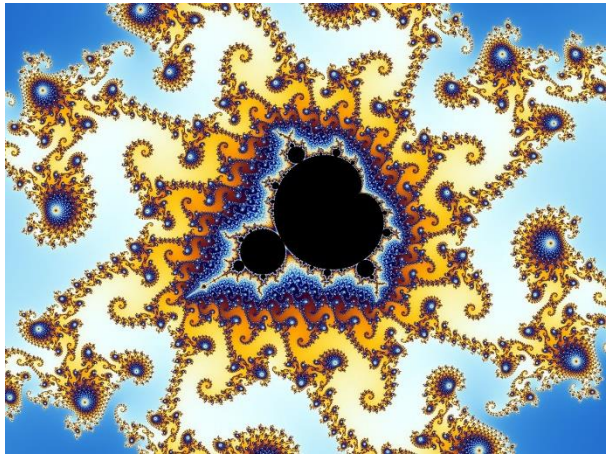
⇨ Do we have a suitable approach? (“linear” DPSIR thinking)

Todays challenge in scientific research

- Complicated



- Complex



What is missing in current research on EPs?

- In regard to solid research questions:
  - Material flow analysis
    - Pathways; sinks; processes in system for all EP groups
    - Exposure assessment
  - Link to “conventional” water quality parameters
    - Ecology in WFD
    - Monitoring of WWTPs (UWWD)
    - DALYs
  - Hazard Identification (where in the system is the problem)
    - Suitable endpoints; not necessarily (eco-)toxicological ones
    - Understanding of internal system stabilities

What is missing in current research on EPs?

- In regard to solid research questions (cont):
  - Units (ABR & MP);
  - Bringing together and discussing knowledge of individuals in a transdisciplinary discussion
  - Awareness to extrapolate from the specific to the general
  - Raising questions first and afterwards choosing methods
  - Honest indication of methodological limitations
  - From a simple (naive) start to complexity
    -> simplification is needed again
  - From research to science

⇨ Maybe not “rocket science”, but another link to system understanding

What is missing in current research on EPs?

- Slowing down!
- Time / money to think!
- Time / money to talk!

- Making it more simple & communication outside of scientific community
  - 1 simple picture
  - 1 page policy paper supported by funding bodies
  - “take home message” not a compilation of results

What is needed

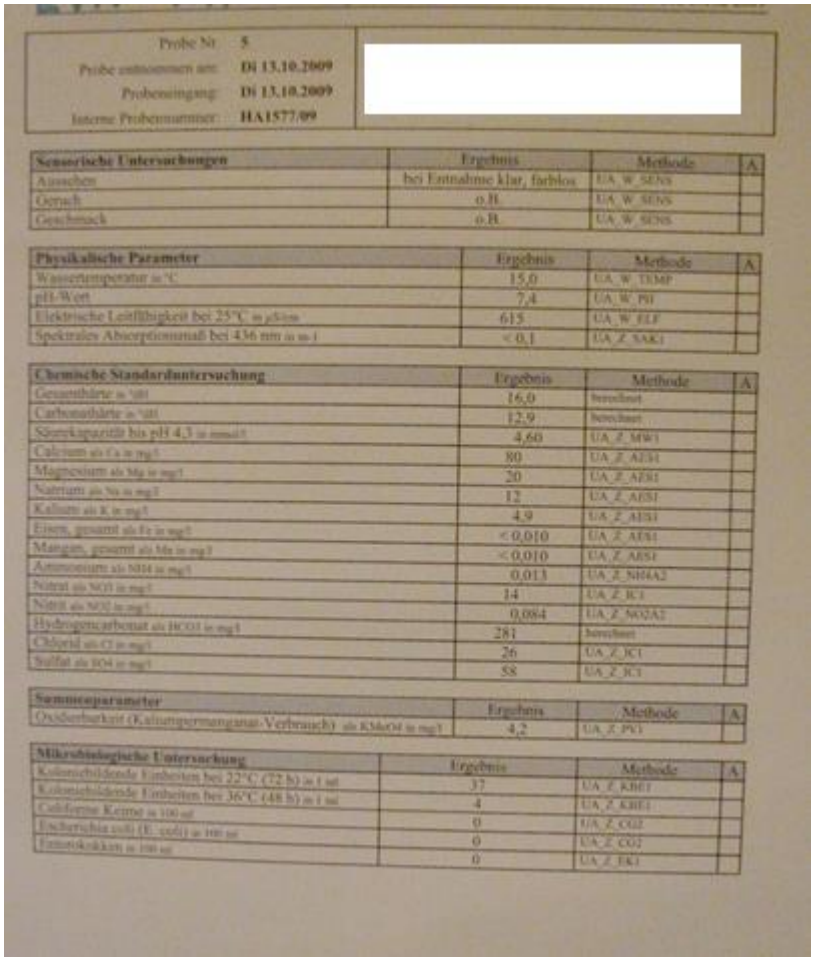
- Everything that is missing ;-)

&

- New systematic scientific approach for understanding of complex systems
- Transfer of information / data to knowledge
- More thinking and transdisciplinary talking than “action”.
- Pudency and being brave (admit knowledge gaps)
- Stepwise approach (20 year steps)
- Communication in pictures

Communication

https://www.adsoftheworld.com/media/print/perrier_melt_club



Probe Nr	5
Probe entnommen am:	Di 13.10.2009
Probeneingang:	Di 13.10.2009
Interne Probennummer:	HA1577/09

Sensorische Untersuchungen	Ergebnis	Methode	A
Aussehen	bei Entnahme klar, farblos	UA_W_SENS	
Geruch	o.B.	UA_W_SENS	
Geschmack	o.B.	UA_W_SENS	

Physikalische Parameter	Ergebnis	Methode	A
Wassertemperatur in °C	15,0	UA_W_TEMP	
pH-Wert	7,4	UA_W_PH	
Elektrische Leitfähigkeit bei 25°C in µS/cm	615	UA_W_ELF	
Spektrales Absorptionsmaß bei 436 nm in m-1	< 0,1	UA_Z_SAK1	

Chemische Standarduntersuchung	Ergebnis	Methode	A
Gesamthärte in °dH	16,0	berechnet	
Carbonathärte in °dH	12,9	berechnet	
Säurekapazität bis pH 4,3 in mmol/l	4,60	UA_Z_MW1	
Calcium als Ca in mg/l	80	UA_Z_AES1	
Magnesium als Mg in mg/l	20	UA_Z_AES1	
Natrium als Na in mg/l	12	UA_Z_AES1	
Kalium als K in mg/l	4,9	UA_Z_AES1	
Eisen, gesamt als Fe in mg/l	< 0,010	UA_Z_AES1	
Mangan, gesamt als Mn in mg/l	< 0,010	UA_Z_AES1	
Ammonium als NH4 in mg/l	0,013	UA_Z_NH4A2	
Nitrat als NO3 in mg/l	14	UA_Z_IC1	
Nitrit als NO2 in mg/l	0,084	UA_Z_NO2A2	
Hydrogencarbonat als HCO3 in mg/l	281	berechnet	
Chlorid als Cl in mg/l	26	UA_Z_IC1	
Sulfat als SO4 in mg/l	58	UA_Z_IC1	

Summenparameter	Ergebnis	Methode	A
Oxidierbarkeit (Kaliumpermanganat-Verbrauch) als KMnO4 in mg/l	4,2	UA_Z_PC1	

Mikrobiologische Untersuchung	Ergebnis	Methode	A
Koloniebildende Einheiten bei 22°C (72 h) in 1 ml	37	UA_Z_KBE1	
Koloniebildende Einheiten bei 36°C (48 h) in 1 ml	4	UA_Z_KBE1	
Coliforme Keime in 100 ml	0	UA_Z_CO2	
Escherichia coli (E. coli) in 100 ml	0	UA_Z_CO2	
Enterokokken in 100 ml	0	UA_Z_EK1	

inspired from B. Renner – University Konstanz, D

What is needed

- (additional) Funding schemes that
  - allow thinking and talking
  - do not urge researchers to promise everything
  - do not have publications as evaluation criterium (Scientists have to publish anyhow ;-)
  - Eg: COST^{+} - intermittent scheme between traditional COST and research projects for consolidation of knowledge
    - year 1&2: submitting team looks for groups with a strong focus on the specific field in Europe and approaches them; they discuss their data and exchange knowledge; money for urgent aspects to address
    - Year 3&4: going broad; all aspects of traditional COST actions

2 final words

- No relevant arguments for me:
  - Costs
  - Energy

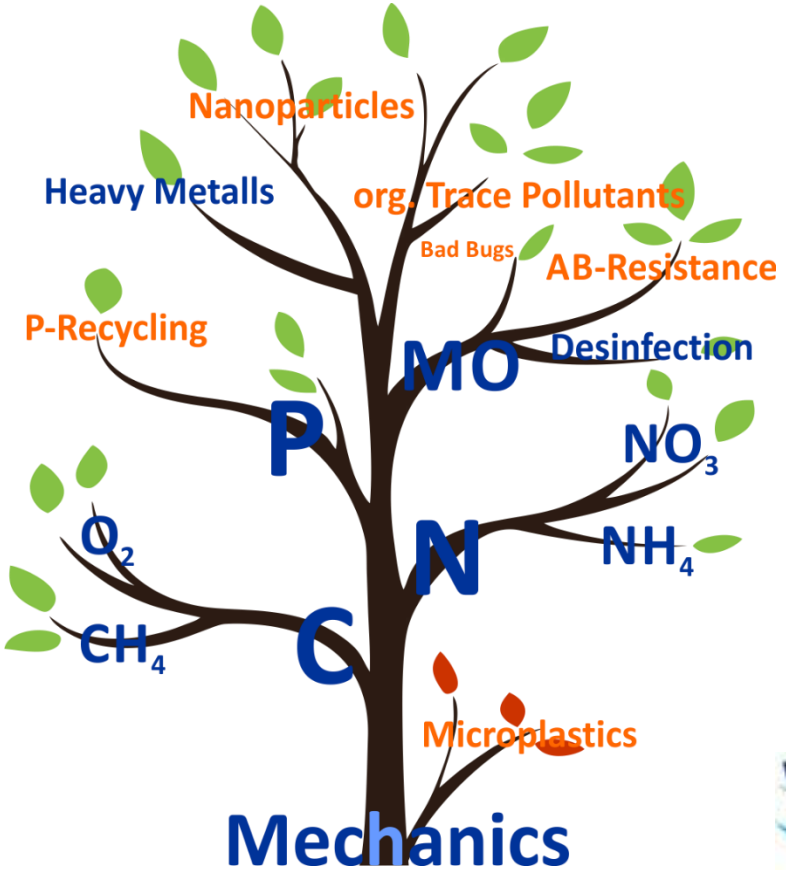
Actually it seems, we already have the answer:

42

But then: what was the question?

Or as an alternative approach: Commitment to minimize our ecological footprint (and follow the precautionary principle)

Thank you for your attention!



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