IWAMA
Interactive Water Management

Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

TALLINN UNIVERSITY OF TECHNOLOGY

Pharmaceuticals in municipal sludge – is it real threat or should it be ignored?

Egge Haiba

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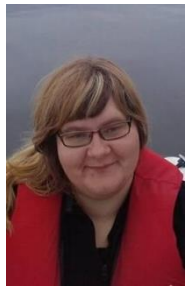


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Composting studies

The presence and degradation of pharmaceuticals -

1. in sewage sludge and its compost;
2. plant uptake of selected pharmaceuticals from fertilized soils;
3. the bulking agent effect on the degradation of pharmaceutical residues present in sewage sludge compost;
4. the impact of these pharmaceuticals on microbial activity.

Pharmaceuticals

- Purpose - prevention and treatment of diseases
- Effect on humans/animals - weak knowledge
- Degradation /no degradation + metabolites

- ~4,000 drug substance is used in Europe (human and veterinary),
- ~250 medical compounds are studied (mostly found in the water environment),
- consumption -> no reliable information,
- releases to the environment are not controlled -> a potential threat to the environment
- the most frequently occurring drug concentrations between
  - ng/L to low µg/L in treated wastewater
  - µg/kg to low mg/kg (dry weight) in biosolids

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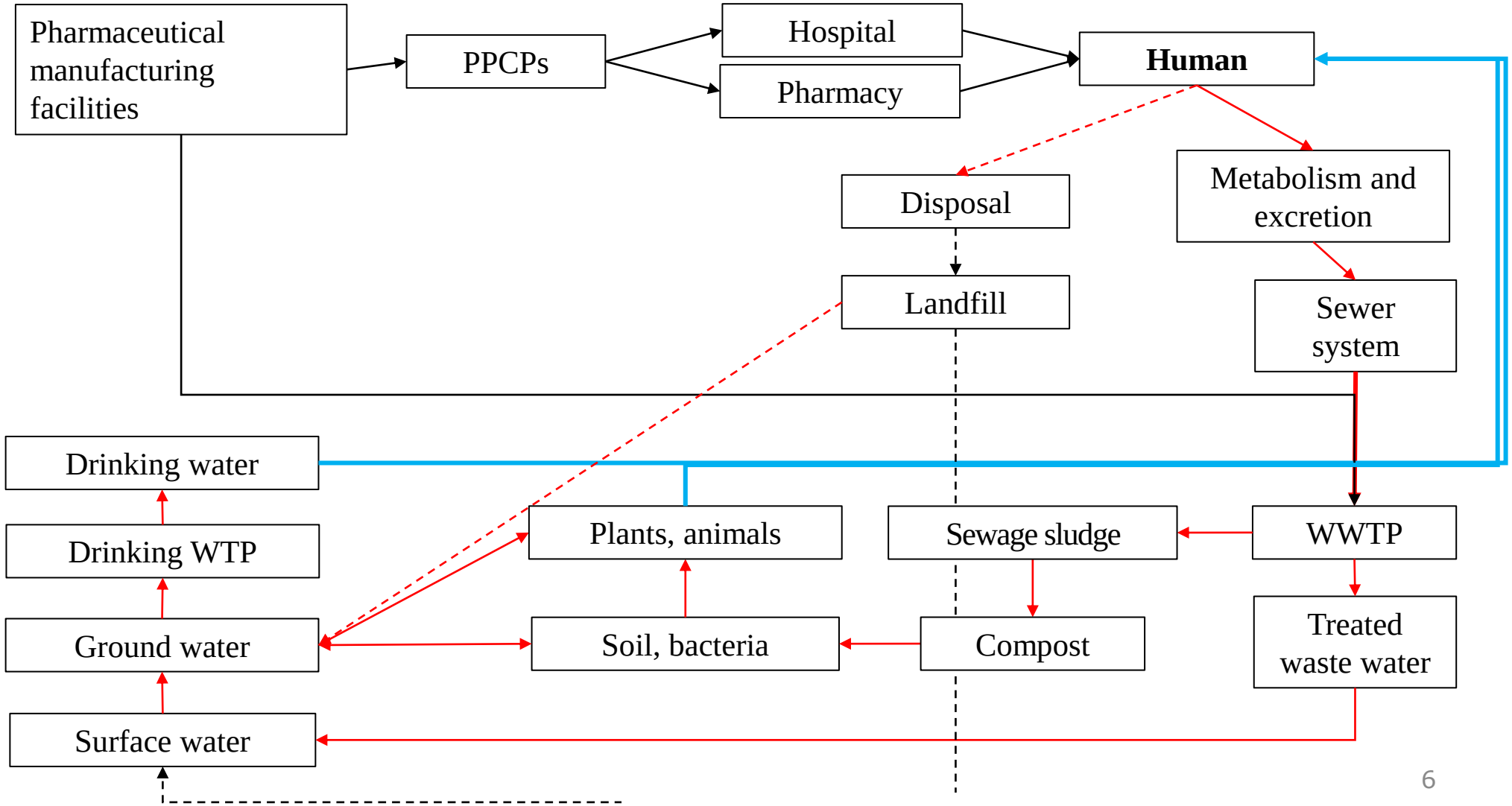
Fate of human pharmaceuticals in the environment



Haiba, 2017

Pharmaceuticals in sewage sludge

Contaminants (Treated sewage sludge):

- Heavy metals
- Fecal coliforms
- Helminths eggs

} Trigger value

EU Council Directive 86/278/EEC, 1986

Other:

- PHARMACEUTICALS → NO trigger value

- EMEA/CVMP (1996) - the content of veterinary medicines should not exceed 100 µg kg^{-1} in manure, and 10 µg kg^{-1} in soil fertilized with manure
- Recommended value considerably lower – 1 µg kg^{-1} for the soil and 0,4 ng L^{-1} for the water compartment

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Pharmaceuticals in sewage sludge

- Pharmaceuticals are present in different concentrations in effluents and biosolids.
- Some pharmaceuticals do not decompose during sewage sludge treatment
- Sewage treatment facilities do not remove all pharmaceutical residues completely.
- Effluent and biosolids are reused in agriculture for irrigation and fertilisation.
- In soil APIs can affect microorganisms, accumulate in plants and may have adverse effects on living organisms.

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Sewage sludge as fertilizer

A major public concern regarding agricultural applications of treated wastewater and biosolids is the introduction of contaminants such as PPCPs from these “waste streams” to crops via plant uptake.

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Pharmaceuticals in plants (Lillenberg, 2011)

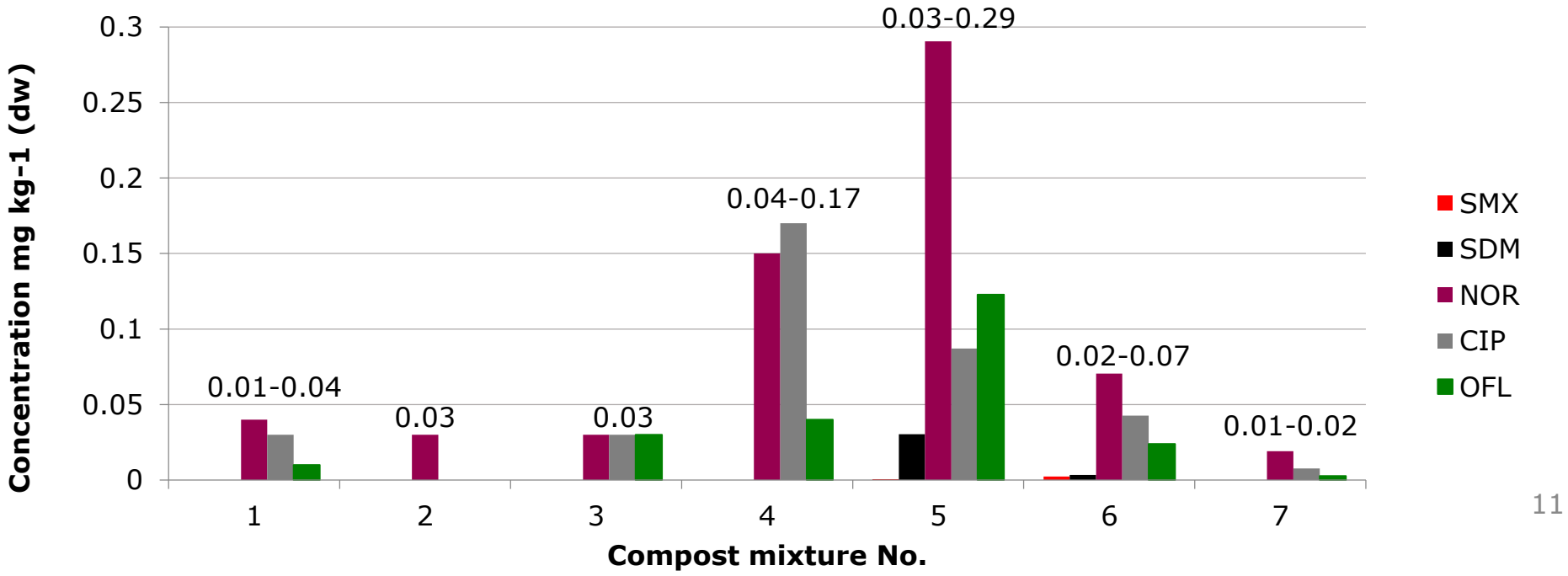
Lettuce samples.

Potato samples

Initial content of antibiotics in sludge (Haiba, 2017)

- Antibiotics tested:
  SMX - sulfamethoxazole, SDM - sulfadimethoxine,
  NOR - norfloxacin, CIP - ciprofloxacin and OFL - ofloxacin

- Contents of pharmaceuticals were detected in fresh compost mixtures.



Pharmaceuticals in sludge and compost (Haiba, 2017)

- PPCPs tested:

DFC - diclofenac, CBZ - carbamazepine,
MET – metformin and TCS - triclosan.

PPCP	Mixture ratio (v:v)	Before spiking	1 day	1 week	1 month
DCF	1:2	0.09±0.00	2.65±0.32	1.31±0.04	0.21±0.01
	1:3	0.06±0.00	2.38±0.21	1.37±0.04	0.04±0.00
CBZ	1:2	0.06±0.00	3.11±0.38	2.59±0.05	3.20±0.01
	1:3	0.05±0.00	2.69±0.26	2.31±0.08	2.32±0.08
MET	1:2	0.00±0.00	2.14±0.25	0.44±0.02	0.18±0.01
	1:3	0.00±0.00	1.95±0.15	0.23±0.02	0.14±0.02
TCS	1:2	**1.77±0.06**	4.54±0.38	3.24±0.20	2.07±0.12
	1:3	**1.23±0.07**	3.53±0.14	2.54±0.09	0.68±0.02

On the degradation of some pharmaceuticals (Haiba, 2017)

PPCP	Mixture ratio (v:v)	Haiba, 2017			Data from literature		
		k (d^{-1})	$t_{1/2}$ (d)	%	k (d^{-1})	$t_{1/2}$ (d)	%
MET	1:2	0.22	3	91	0.12 … 0.26[A] 0.22 … 0.27[C]	1 … 5[A] 2 … 3[C]	99 …100[A]
	1:3	0.27	3	93			
DCF	1:2	0.09	7	92	0.23 … 0.16[A] 0.010[B]	3 … 4[A] 70[B]	26[B]
	1:3	0.09	8	98			
TCS	1:2	0.03	26	55	0.05 … 0.04[A] 0.02[B]	13 … 20[A] 35[B]	45[B]
	1:3	0.05	13	81			
CBZ	1:2	0.00	222	-11		46…173[a]	
	1:3	0.00	178	13			

[A] agricultural soil
[B] sterile soil
[C] compost mixture

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Pharmaceuticals in the environment- what is the threat?

- Some pharmaceuticals degrade, some are persistent
- Highly persistent APIs are able to accumulate in plants and animals.
- High levels of APIs in the environment - dangerous to water and soil organisms.
- Low drug levels in the environment - soil and water microbes develop drug resistance.
- High drug levels in food (animal feed) - destructive to plants, dangerous to human (animal) health.
- Low drug levels in food (animal feed) - the development of drug-resistant microbes in humans or animals.

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Clear waters from pharmaceuticals - CWPharma

- works on reducing information gaps regarding :
  - sources,
  - emissions and
  - environmental concentrations of APIs in the Baltic Sea.
- The project evaluates different API emission reduction measures.
- The best existing practices of the partner countries shall be shared in order to promote the sustainable management of APIs in the Baltic Sea region.
- http://www.syke.fi/en-US/Research_Development/Research_and_development_projects/Projects/Clear_waters_from_pharmaceuticals_CWPharma

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Thank you for your attention!

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