

Institute for Sanitary Engineering, Water Quality and
Solid Waste Management

Universität Stuttgart



**Determination of Organic
Contaminants in Compost and
Digestates in Baden-Württemberg,
Germany**

Dr. Bertram Kuch
Dipl.-Chem. Silke Rupp
Dipl.-Chem. Jessica Stäb
Prof. Dr. Jörg W. Metzger
Dept. Hydrochemistry

Dr.-Ing. Klaus Fischer
Prof. Dr.-Ing. Martin Kranert
Dept. Solid Waste Management

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Aims

Improvement of data basis for selected organic compounds
in composts and digestates

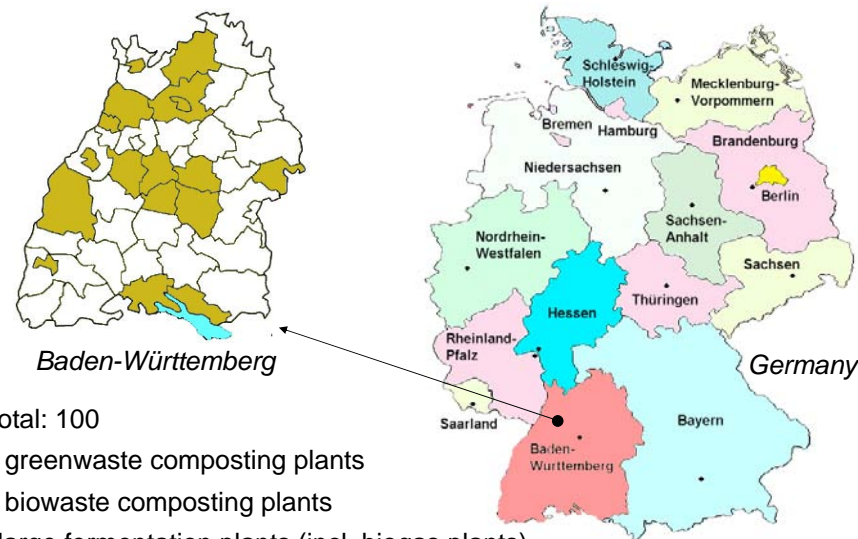
- which organic compounds are present?
- differences in concentration for composts and
digestates?
 - dependence on input material
(biowaste vs. greenwaste)?
 - dependence on kind of treatment?
- seasonal changes in concentration?

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Composting Plants in Baden-Württemberg



Baden-Württemberg *Germany*

In total: 100
 61 greenwaste composting plants
 26 biowaste composting plants
 13 large fermentation plants (incl. biogas plants)

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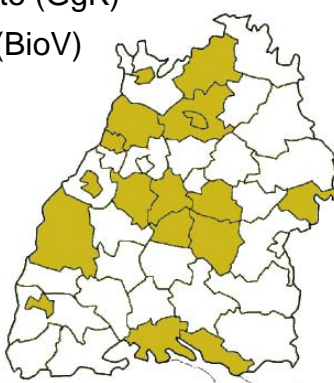
Selection of Plants for Study


10 composting plants for biowaste (BioK)
 3 composting plants for greenwaste (GgK)
 3 fermentation plant for biowaste (BioV)


16 in total
 Capacity: 2.500 bis 84.000 tons/ year

Criteria for Selection:

- quality control (RAL) of composts by *Bundesgütegemeinschaft Kompost (BGK)*
- input from both urban and rural origin
- different treatment processes





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Selection of Organic Pollutants (I)

- *compounds found in literature as pollutants in compost*
- *relevance due to EU Water Framework Directive (list of priority substances) and/or Stockholm Convention*
- *results of random (GC-MS) screening prior to investigation*

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Selection of Organic Pollutants (II)


Polycyclic aromatic hydrocarbons (PAH)

Chlorinated aromatic compounds

- Polychlorinated Biphenyls (PCB)
- Chlorobenzenes
- Triclosane
- (DDT metabolite DDE)

Brominated aromatic compounds

- Polybrominated diphenyl ethers (PBDE)
- Tetrabromobisphenol A
- Brominated phenol ethers
 - 2,4,6-Tribromophenyl-allylether (TBPAE)
 - 2,4,6-Tribromophenyl-(2,3-dibrompropyl)-ether (TBPDBPE)
- Bromobenzenes


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Selection of Organic Pollutants (III)

Phenolic compounds
4-Nonylphenol and 4-tert-octylphenol

Others
Diethylhexylphthalate (DEHP)
7-Acetyl-1,1,3,4,4,6-hexamethyl-tetraline (AHTN)
Tris-(chlorpropyl)-phosphat (TCPP)
Pharmaceutical products




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Analytical Methods

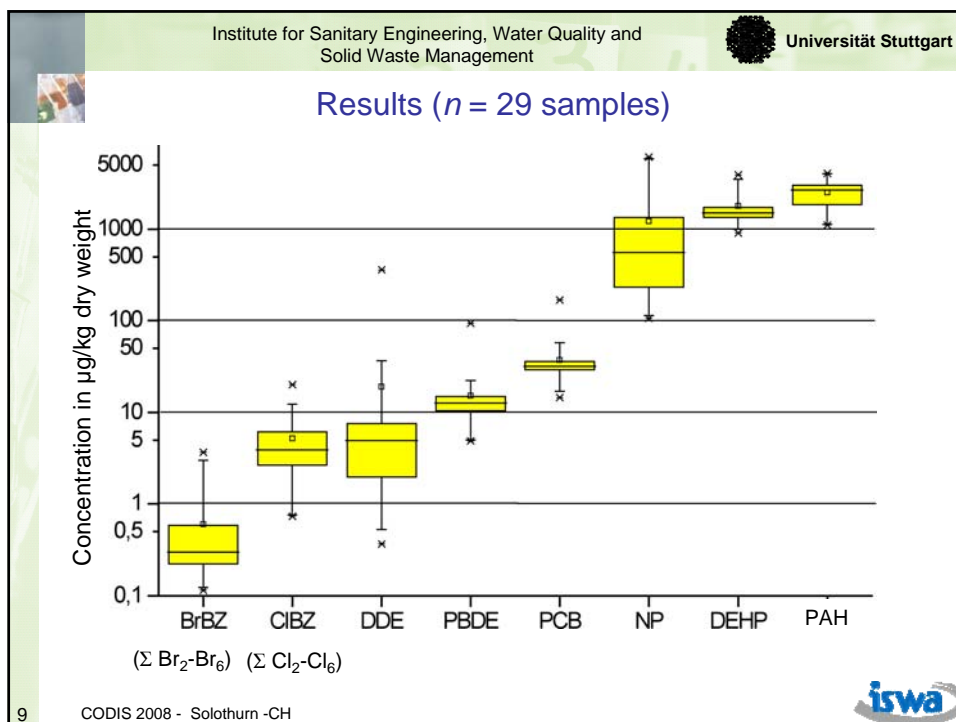
Compost sample	
↓ Lyophilization	
Homogenization	Grindig mill, < 250 µm
↓ Soxhlet Extraction	Methanol/ diethyl ether/ conc. HCl 100:10:0,01 v/v/v; 12 h
Soxhlet Extract	Reference sample
↓ Clean Up	
Aliquot 1	PBDEs, PCBs, halogenobenzenes
Aliquot 2	PAHs
Aliquot 3	Phenols, pharmaceuticals
Aliquot 4	Phthalates
GC/MS	
Quantitation: Isotope dilution method	



6 Indicator-PCB
16 PAHs (US-EPA)



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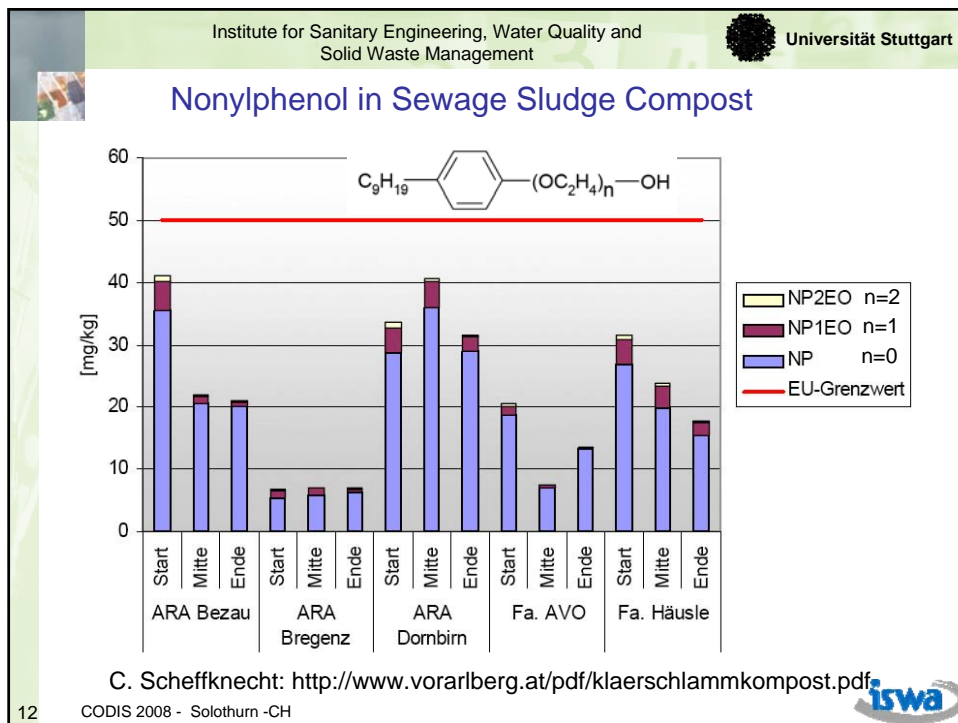
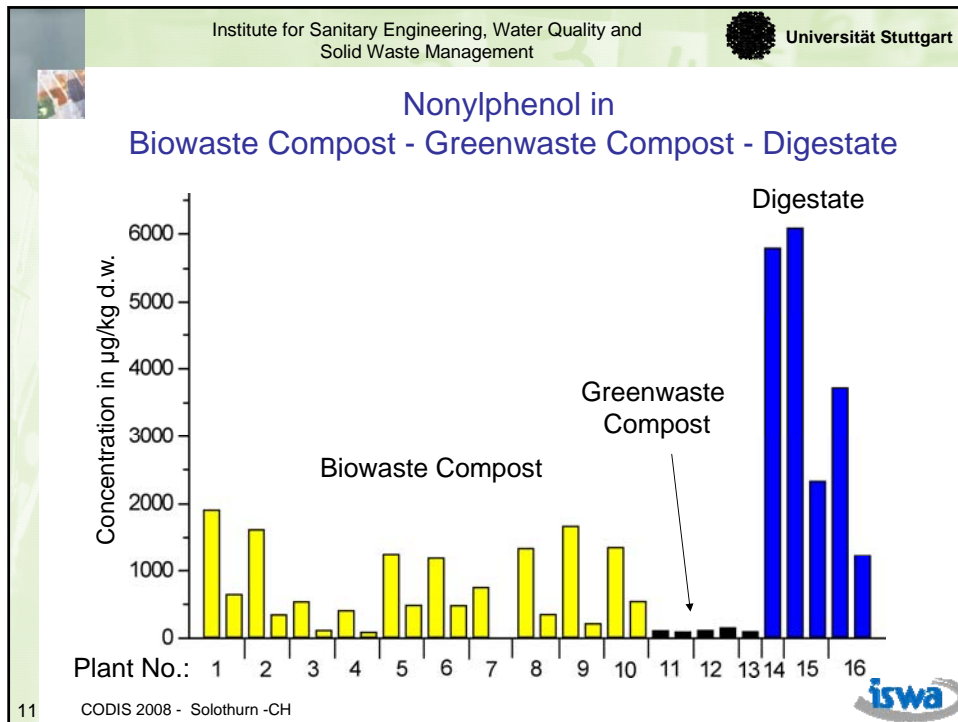


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Results

Compound	Biowaste	Greenwaste	Digestate	Soil
	(Median Concentrations in µg/kg d.w.)			(min - max)
PAH (16 /6)	2659/1312	2026/1216	3498/1459	
4-Nonylphenol	570	24.0	2119	
Benzo(a)pyrene	75.0	139	75.0	
11 - 33				
PCB (6)	33.4	20.8	29.9	1.8 - 8.6
TCCP	16.0	5	177	
4-tert-Octylphenol	15.0	4.0	115	
PBDE (11)	13.0	5.4	13.7	0.4 - 0.6
TBPAAE	7.0		< l.o.d.	
AHTN	6.0	-	68	
DDE	5.5	1.9	7.5	0.9 - 5.5
Hexachlorobenzene	2.9	0.83	3.8	0.3 - 1.0
TBPDBPE	1.5		< l.o.d.	
DEHP	1.4	1.5	3.5	
TBBPA	1.3			
Bromobenzenes (2-6)	0.34	0.19	0.41	
Triclosane	(1.5-11.6)		(10.3)	
Pharmaceutical products	----- < l.o.d. (ibuprofen < 5) -----			

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Comparison: Greenwaste Composts - Biowaste Composts - Digestates

General tendency: **lowest concentrations in greenwaste composts**

Concentrations

PCBs, PBDEs and halogenbenzenes	⇒	Biowaste Composts = Digestates
PAHs, nonylphenols, octylphenol, DEHP, DDE	⇒	Digestates > Biowaste Composts

Reason?

- input material (kind and degree of contamination)
- degradation behaviour/ treatment conditions (aerobic/anaerobic)

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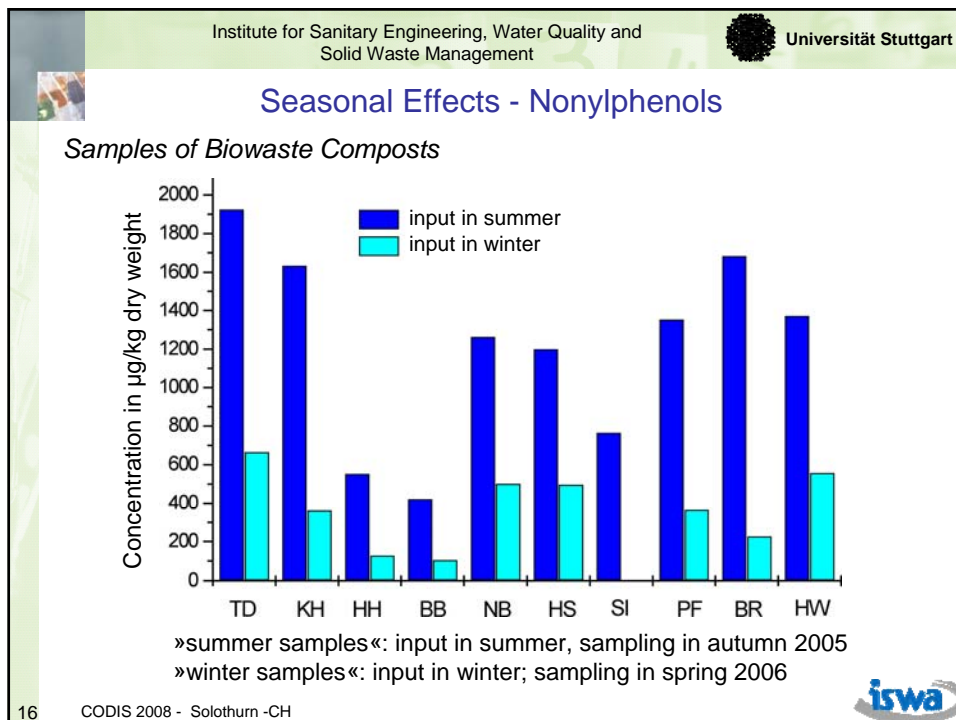
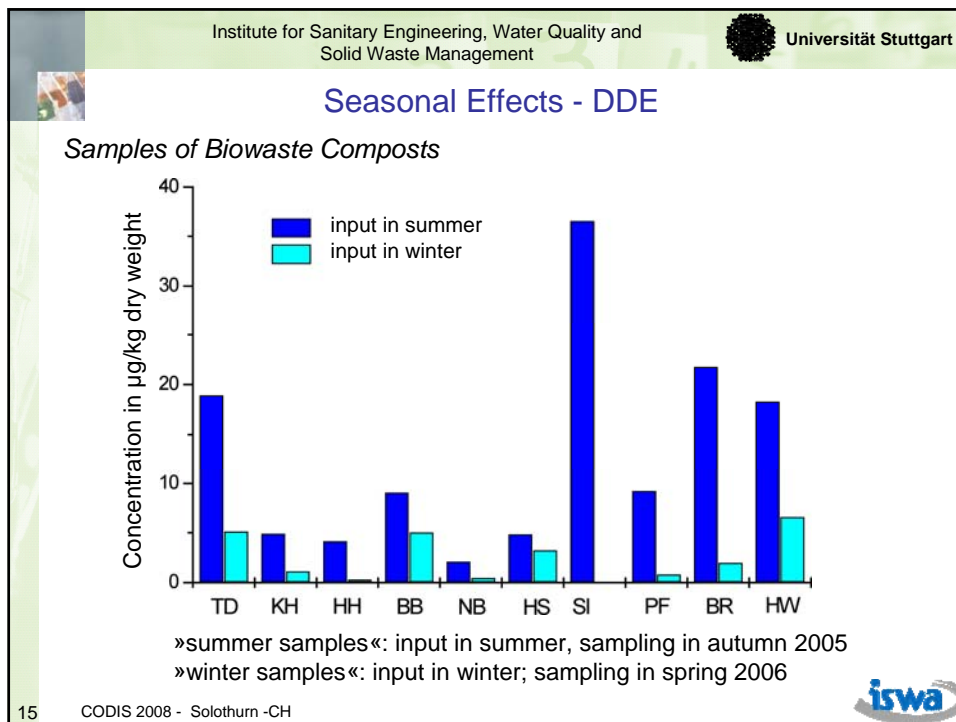
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Seasonal Effects

Samples of Biowaste Composts

Input during winter	PAHs	← fossil fuel consumption slightly higher in winter
Input during summer	Nonylphenols, Octylphenols, DDE	← usage of pesticides in summer


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Summary


- Composts (biowaste > greenwaste) and digestates contain organic pollutants:
 - highest concentrations (up to low mg/kg d.w.) for:
PAH > DEHP > nonylphenols
 - PBDEs, PCBs: present in all samples in the µg/kg d.w.-range
(concentrations lower than that of benzo(a)pyrene)
- the concentrations determined are in agreement with data found in literature
- seasonal effects occur for nonylphenols and DDE (and PAHs)
- sources: aerial deposition, contaminated input material (pesticides), presence of paper and plastics etc. (flame retardants, DEHP)
- with regard to existing regulations (compost, sewage sludge) concentrations found are low (however, in some cases higher than soil concentrations)

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Acknowledgement

Financial support: **Ministerium für Umwelt,
Baden-Württemberg**



Organic pollutants in composts and digestates in Baden-Württemberg/
Untersuchungen von Komposten und Gärsubstraten auf organische
Schadstoffe in Baden-Württemberg
(BWPLUS BWR 24026 01.10.05 - 30.09.06)

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