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# Occurrence and fate of xenobiotics in sewage sludge and in sludge-amended soils

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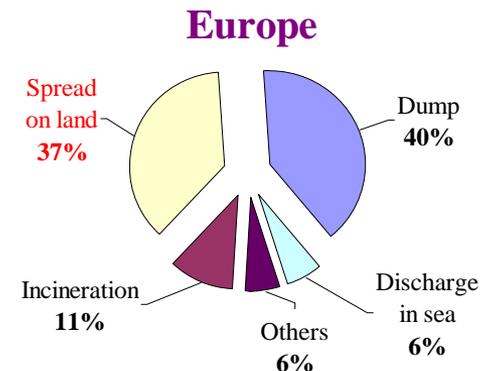
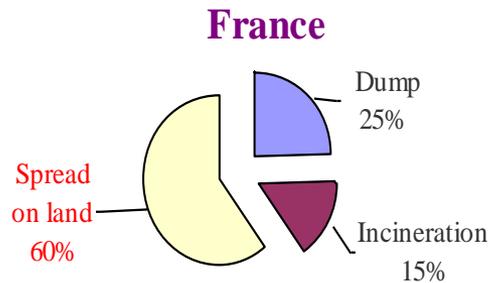
[www.biowaste.dk](http://www.biowaste.dk)

## Wastewater treatment and sewage sludge production...



- over 50.000 ww treatment plants
- ~ 7.9 millions tons of dry solids (2000)
- Amount will increase

## ... and sewage sludge disposal



## Are there Xenobiotics in wastewater ????

Yellow and brown water



Industrial water

Storm water



Grey water



WWTP

Rivers, sediments



Soils, groundwaters



Effluents

Sludges

...and where do they accumulate ???

because of low water solubility  
of high affinity for organic matter

# Goals of the project

Xenobiotics



Sewage sludge spreading  
on agricultural land



Environmental and human risks, public concern

- Contamination of ecosystems and natural resources (soil, water, air)?  
> *Ecotoxicological risk assessment*
- Drinking polluted waters and eating polluted foods?  
> *Sanitary risk assessment*



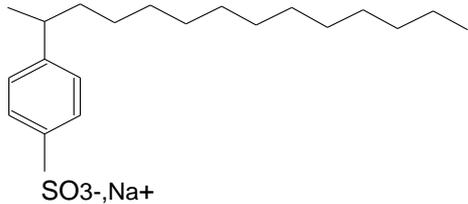
**Occurrence** of xenobiotics in SS

Litterature survey and analysis of european SS

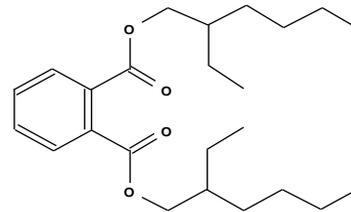
**Fate** of xenobiotics in sludge amended soils

From Lab-scale to field experiment

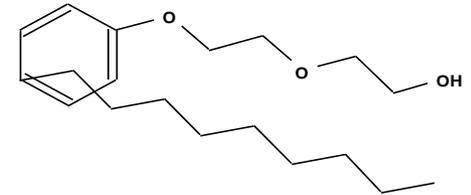
## Xenobiotics assessed in the project



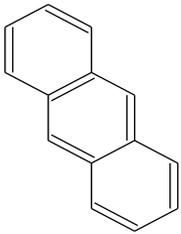
Linear alkylbenzene sulfonate (LAS)



Phthalates



Nonylphenol ethoxylate (NPE)



Polycyclic aromatic hydrocarbon (PAH)

- Listed in EU legislation
- Level of concentration
- High toxicity (ED)
- Low biodegradation
- Persistence

## Litterature survey and analysis

Measurement in water, soil and sediment

Less information in sludge

Various level of concentrations

diverse analytical methodologies (no std)

industrial wastewater

rain runoff collection

population size

type of WW treatment (AS, filters)

type of SS (primary, secondary)

type of SS treatment (AD, composting)

time (date, season, day)

# Occurrence of xenobiotics in SS

Typically found concentration in EU SS

LAS : 100 - 15000 mg/kg DW

NPE : 25 - 500 mg/kg DW

Phthalates : 10 - 600 mg/kg DW

PAH (16) : 0.1 - 10 mg/kg DW

for other : less than 1 mg/kg to µg/kg

3rd draft  
of the SS  
EU  
Directive

2600

50

100

6

## Lab-scale experiments : microcosms and radiolabelled molecules



**Unpolluted soil as control**  
**Soil spiked with labelled  $^{14}\text{C}$ -xenobiotic**  
**Soil amended with a diverse spiked SS**  
     **non-transformed SS**  
     **anaerobically treated SS**  
     **anaerobically and composted SS**

Adsorption - bound residus ?

Volatilization ?

Degradation - metabolites ?

Transfer to water or plant (radish) ?

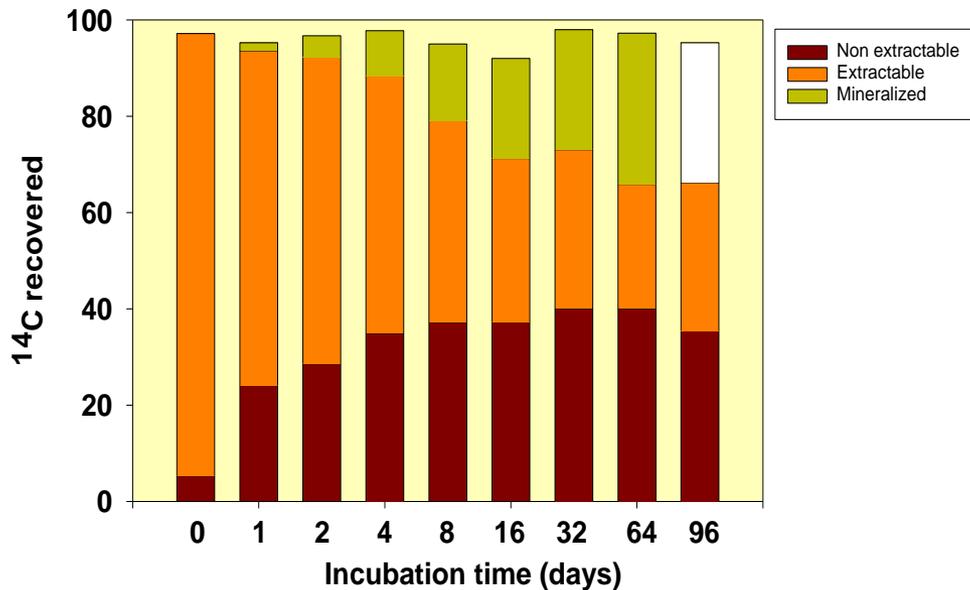
Impact on bacterial and fungal communities ?

# Fate of xenobiotics in sludge amended soils

## Lab-scale experiments : microcosms and radiolabelled molecules

### NP spiking on soil

27 g dry silt loam sieved at 2 mm  
 40 mg/kg t-NP\*, 80 % MHC, 25°C, darkness



<sup>14</sup>C-balance +  
 HPLC analysis:

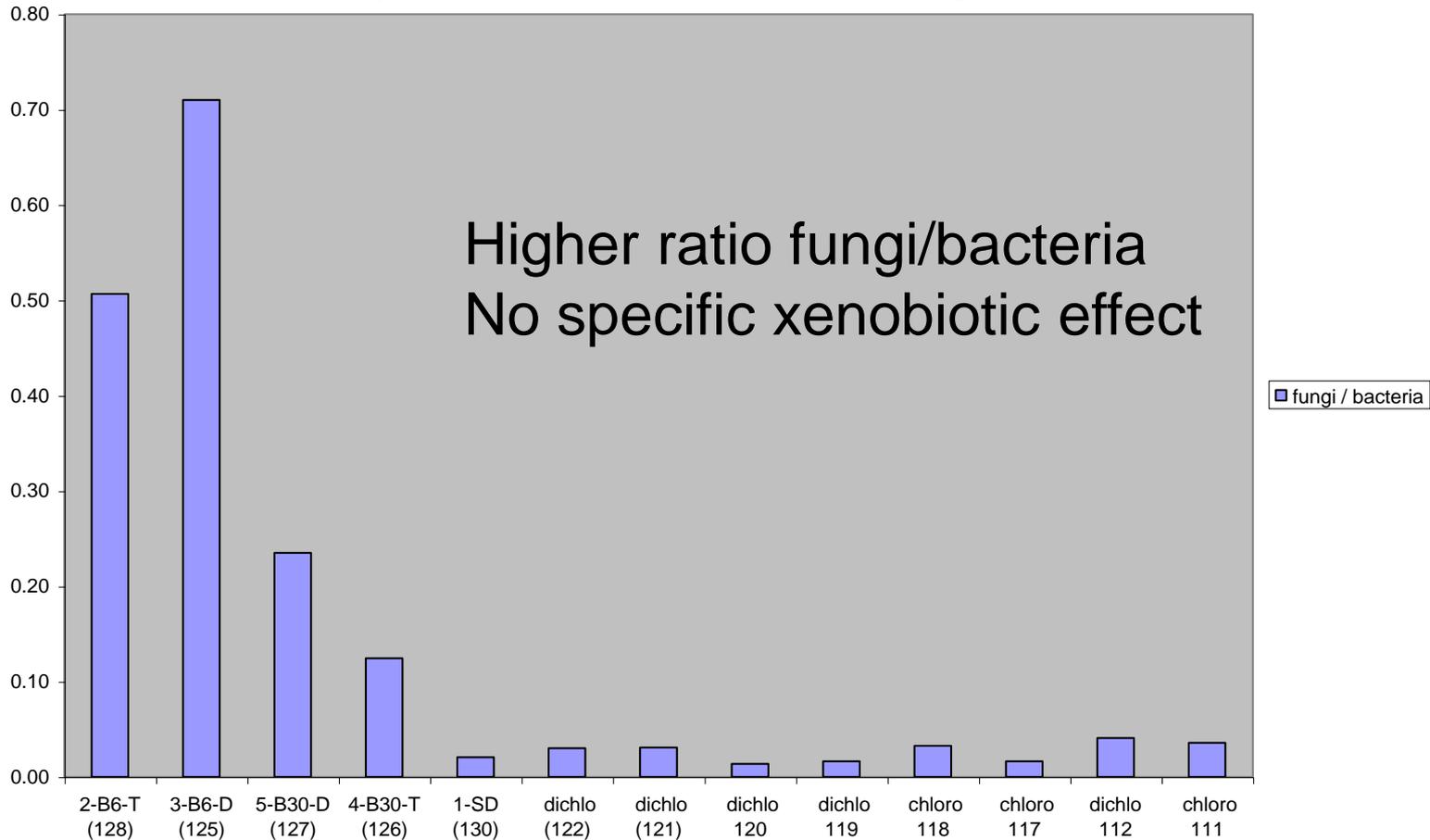
**T<sub>1/2</sub> ≈ 4 days**

- Fast dissipation
  - mineralization
  - formation of bound residus
- Strong impact of the SS
  - delay of degradation
  - higher adsorption
  - half life of 16 d and more
- Low transfer to the plant
  - less than 9% radioactivity
  - metabolites ?
- Impact on microorganisms
  - higher PLFA concentration
  - higher ratio fungi/bacteria

# Fate of xenobiotics in sludge amended soils

Lab-scale experiments : microcosms and radiolabelled molecules

Impact of sludge amendment on microorganisms : PLFA analysis



# Fate of xenobiotics in sludge amended soils

## Field experiment

### Experimental maize crops, Bordeaux, France

Sludges addition **100 tons sludges/ha/2yr** (total 1000 tons)

← Sampling →

← →

1974

1993

2004



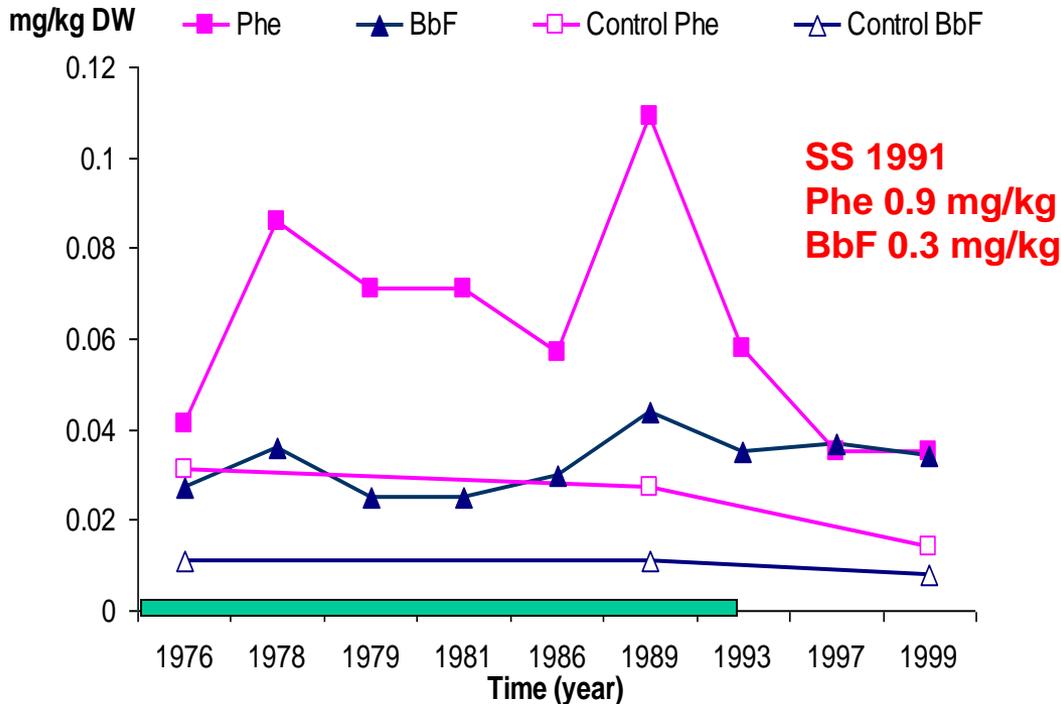
Analysis of LAS, NPE,  
Phthalates and PAH



# Fate of xenobiotics in sludge amended soils

## Field experiment

### Results on PAH



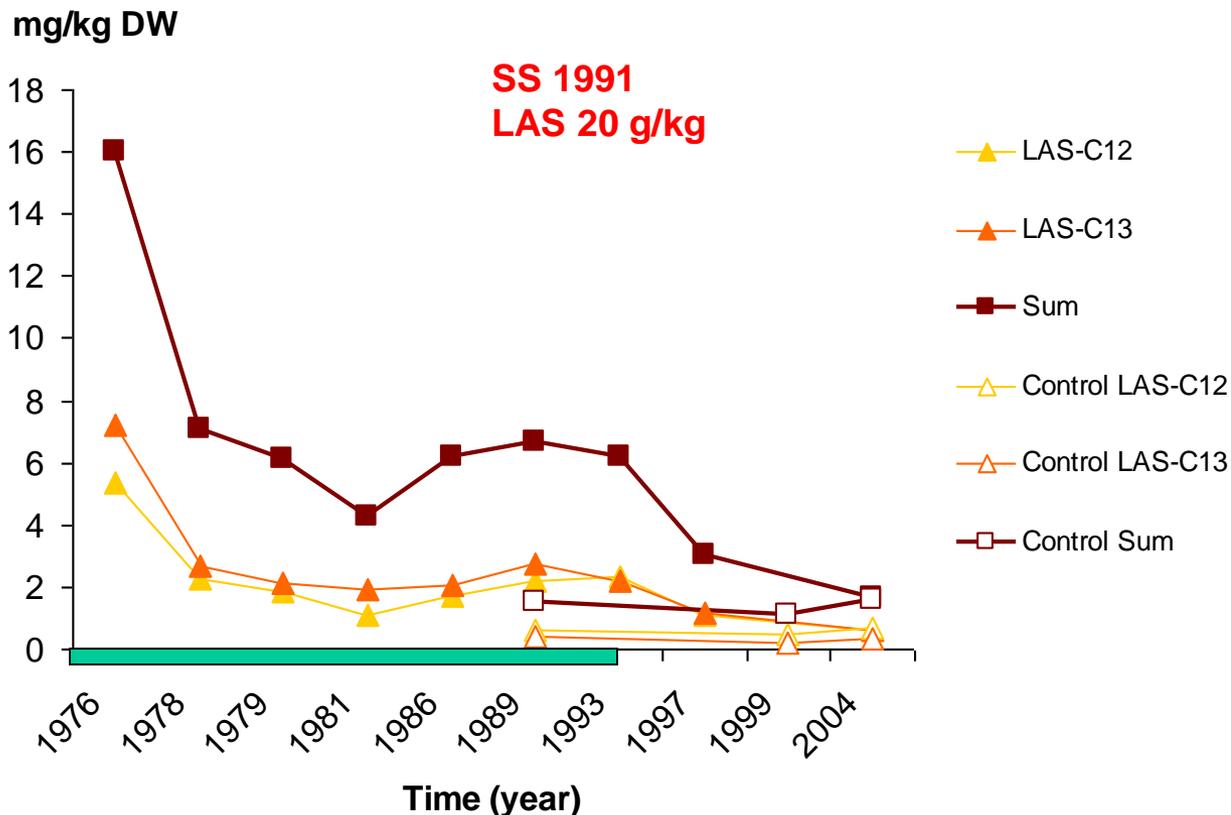
- PAH concentration 2-5 x higher in sludges-amended soils.
- Levels increase during sludges addition.
- Levels still high 7 years after end of sludges addition.
- Different behaviour towards molecular weight

**Long term impact of high molecular weight PAH**

# Fate of xenobiotics in sludge amended soils

## Field experiment

### Results on LAS



- Higher LAS concentration in SS
- Decrease and stabilization  
Adaptation - degradation - mobility?
- Decrease to background level after 10 years

Higher degradability (or mobility?)...  
....less residual concentration in soil

- **Development of new methods for Xenobiotics analysis**  
Overview of occurrence and level of xenobiotics in EU SS
  
- **Fate in soil**  
Fate of X in sludge-amended soil is adsorption-degradation dependant  
Low transfer to plant and water  
Long term soil accumulation of xenobiotics after sludge spreading for the less degradable and most hydrophobic compounds
  
- **Impact**  
Be careful to the mixed effect : sludge and xenobiotics in sludge  
Measured effect at even high load of SS. What about at normal load?

## Thank you for your attention



» Men walked on the moon, now it's time they learn how to walk on earth... «  
[ Henri de la Bretèche ]