

Organic pollutant accumulation in vegetation from the soil fertilized by biogas plant end products: model variables

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Major pathways for organic pollutants into the food chain leading to human beings

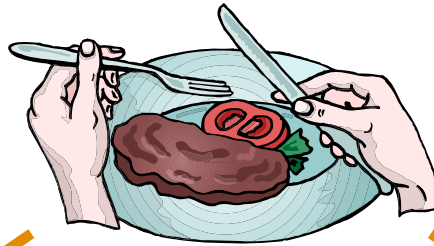
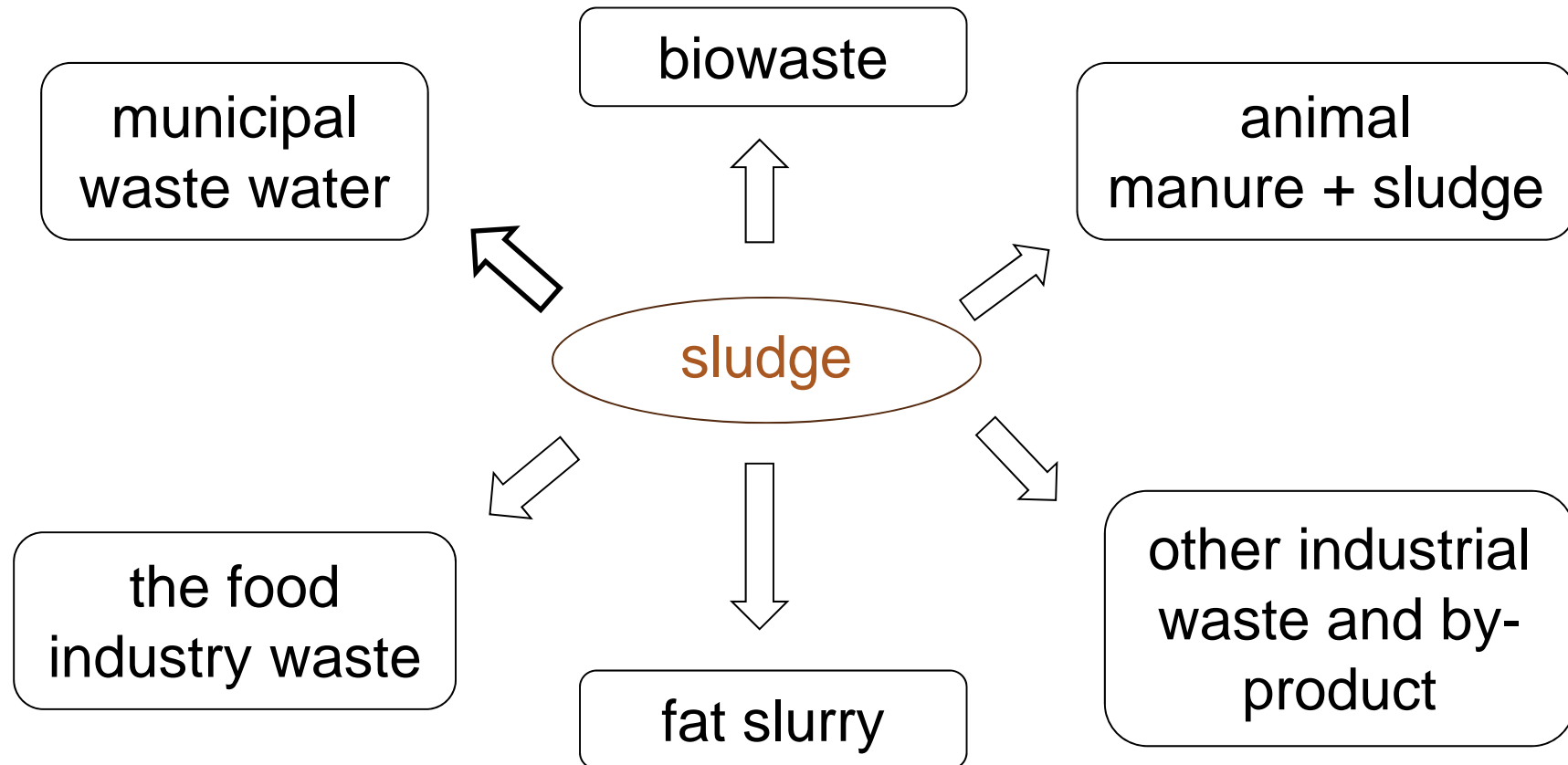


Image: Anniina Kivilahti



Image: Kristiina Kanerva

The components of the studied sludge



Concentrations of the organic pollutants in sludge

- The limit value of using sludge as organic fertilizer is controlled by the authorities in order to control pollution.
- The Finnish legislation require to analyze sludge produced by biogas plants for the presence of other contaminants, such as, for example, phosphorus (P), nitrogen (N), cadmium (Cd), etc.
- The amount of sludge produced by the companies is regulated according to the concentrations of all contaminants defined to be hazardous by the governmental limitations.

Contaminants in the environment can enter plants by various ways

I. From soil:

- uptake with transpiration water;
- diffusion from soil into roots;
- attachment of soil particles, eventually followed by diffusion into plant tissue.

II. From air:

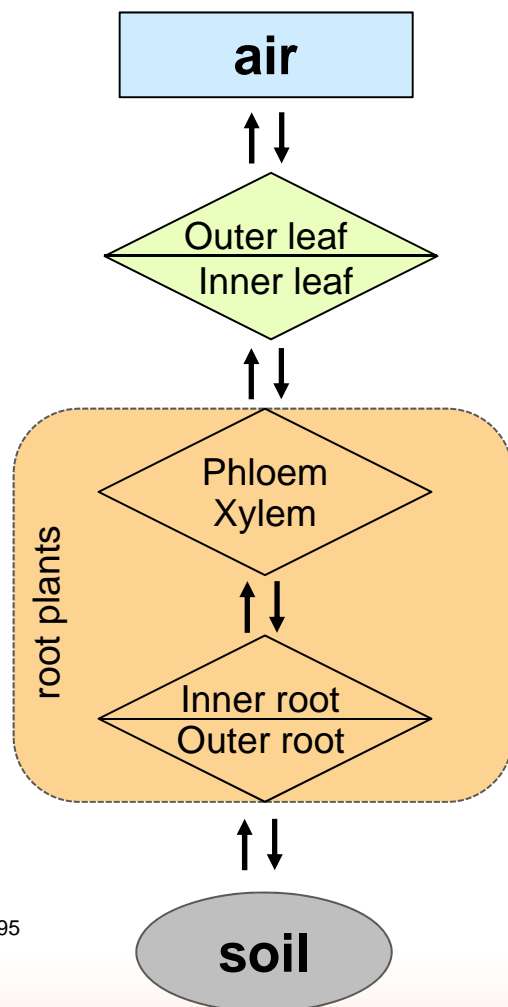
- gaseous exchange with air;
- wet and dry particles deposition from air on plant surfaces, followed by diffusion into plant tissue.

Modeling of plant contamination processes is of growing interest

There are many different processes that can be included to the model:

- translocation to shoots
- gaseous deposition on leaves
- volatilization from leaves
- metabolism and degradation processes
- dilution by exponential growth

Simplified mechanism of pollutant uptake by plant



Inspired by Simonich et al. 1995

- the chemical and physical properties of the pollutant

- environmental conditions

- the plant species

The uptake of pollutants into plants and their accumulation depend on contaminant specific parameters

The most relevant contaminant-specific parameter in the root models is the $\log K_{ow}$, which is varied from 0 to 8.

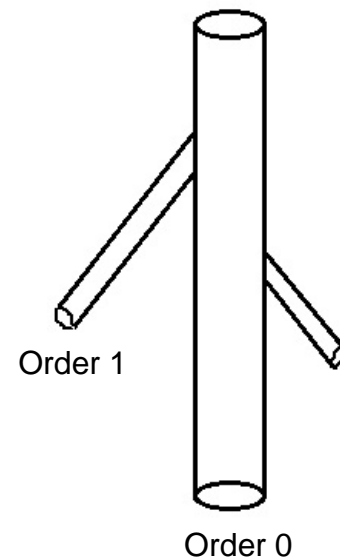
$$K_{ow} = \frac{[C]_{\text{octanol}} \text{ mol liter octanol}^{-1}}{[C]_{\text{water}} \text{ mol liter water}^{-1}}$$

- *Hydrophilic compounds.*
- *Lipophilic compounds.* (PCDD/F, PCBs, PAHs). The main accumulation pathway is from air to the leaf surface and animal grazing.

Root branching structure

Two different root systems:

- root vegetables, such as radishes, carrots
- the root system of agricultural plants, such as barley



Roose et al., 2004

Empirical methods for estimating uptake of contaminants into plants

- Bioconcentration factor (BCF) – the ratio of contaminant concentration in an organism to contaminant concentration in the surrounding medium.

$$BCF = \frac{[C]_{\text{plant}}}{[C]_{\text{soil}}}$$

Trapp et al., 2010

Data

- Concentrations of organic pollutants in sludge (the end product of biogas plants)
- Concentrations of organic pollutants in the soil after harvest
- Concentrations of organic pollutants in agricultural plants and vegetations.

Thank you for your attention!

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