Sewage Sludge processing and management perspectives in Europe

PROBLEMS AND SOLUTIONS in WWTP SLUDGE
Sofia
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The public perception of Waste water treatment

Keep off! - Waste water

WWTP
Black Box

Ahh!+

Clean rivers

Brrr!
Sludge Screenings, Grit

NIMBY-PROBLEM
Introduction

Wastewater treatment always results in the production of sludge and some other solids which have to be treated and disposed;

Basic statements

◇ Waste water treatment process can only meet the effluent requirements if the sludge produced can be reliably disposed at any time.

◇ Waste water treatment & sludge handling and disposal have to be designed and operated as one complex unit as they are linked by important material and energy flows.

In European legislation this is not reflected.
Conventional waste water treatment plant configuration

**Mechanical treatment**
- Screen
- Grit chamber
- Primary Settling

**Biological treatment**

**Sludge treatment**
- Thickening
- Stabilisation
- Dewatering
- Incineration

**Sludge disposal**
- Disposal landfill
- Agricultural use, landscaping

**Return flows from sludge treatment**

**Excess Sludge**

**EU WFD 2000/60**

**EU WFD 2008/98**
Sludge production (PS+ES)

Thickening

Stabilisation

Storage

Dewatering

Composting/Drying

Incinerated (stab.) Sludge

Raw sludge incineration (HKA)

optional

Disinfection

Structure material

Composting

Drying

Mono- Incineration

Drying

Energy

Co- Incineration

P-recycling, reuse after extraction

Fertiliser production

Utilisation

- Agriculture
- Landscaping,

Disposal „lock out“
# Economic relevance for WWTPs

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost Estimate</th>
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<tr>
<td>Annual operating costs for sludge treatment and disposal</td>
<td>~45% of total op. costs</td>
</tr>
<tr>
<td>larger plants (&gt;50,000)</td>
<td>≥ 5 €/PE/a</td>
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<tr>
<td>smaller plants (&lt;10,000)</td>
<td>≥10 €/PE/a</td>
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<tr>
<td>appropriate capital costs,</td>
<td>4 to 8 €/p/year</td>
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<tr>
<td>Total yearly costs for sludge treatment and disposal</td>
<td>8-15 €/p/a = 20% of the total costs</td>
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Sludge treatment and disposal is a relevant cost factor for the consumer.
### Economic relevance for Agriculture

<table>
<thead>
<tr>
<th>Economic Aspect</th>
<th>Value</th>
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<tr>
<td>Agricultural budget of EU (subsidies)</td>
<td>~100 €/inh./year</td>
</tr>
<tr>
<td>Monetary value of sludge as N+P fertilizer</td>
<td>&lt;1 % of EU budget</td>
</tr>
<tr>
<td>Value of agricultural production in Austria (value of fertiliser in total sludge prod.)</td>
<td>~1.500 €/ha/year (0,2%)</td>
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<tr>
<td>Local complete substitution of P requirement by sewage sludge at a farm</td>
<td>~30 kg P/ha/year</td>
</tr>
<tr>
<td>⇒ monetary value for farmer (&quot;profit&quot;)</td>
<td>~70 €/ha/year</td>
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Agricultural policy is not interested in sludge! Farmers can be interested if sludge is applied free of charge and if their products have no problems on food market.
EU Legislation and Sludge management
EU Sludge Directive 278/86

- First EU legislation related to waste water treatment
- Developed by waste water experts together with soil protection and agricultural experts (no waste managers involved!)
- Goal: enable agricultural use of sludge without harm to human health, soil fertility and crop deterioration, based on ample research on international level (COST, UK, US, Europe)
EU Sludge Directive 278/86

- Administrative and monitoring requirements for sludge application on agricultural land
- Quality criteria for sludge based on:
  - Heavy metal concentrations in [mg/kg DS]
  - Restrictions for sludge application on sensitive agricultural areas to avoid hygienic problems
  - Hygienic standards for application on pastures
- Restrictions on sludge application per ha and year(s) based on nutrient content
- No marketing aspect (like biosolids in US)
EU Urban Waste Water Directive 271/91

• The Directive lays down the minimum requirements for sewerage and waste water treatment for all settlements >2000 inhabitants.

• It is based on the BAT (precautionary) principle.

• This results in sludge production of about 30 to 40 kg DS/inhabitant/year. At 400 Mio inhabitants connected to WWT i.e. 15 Mio t DS/a with adequate treatment and disposal possibilities.

• This is not reflected in this legislation.
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EU Water Framework Directive 2000/60

• Includes the UWWD and the Sludge Directive
• But does not include any paragraphs on sludge treatment and disposal
• In sensitive areas the link between sludge treatment and waste water treatment becomes relevant also for water protection in regard to nutrient removal, where the environmental standard principle will become more effective in the future (freshwater eutrophication), e.g. for reject water treatment
Waste framework directive (2008/98/EC)

- According to this Directive sewage sludge is a waste and has to be treated, recycled, reused and/or disposed off accordingly.
- Waste management is a business and accordingly the legislation is strongly addressing private initiative and favours market economy.
- There is no provision for the relationship between WWT and sludge treatment/disposal.
- Waste legislation is very different from water legislation for several reasons (causes conflicts).
Priority order of waste management hierarchy:

Introduction of the "polluter pays principle" and the "extended producer responsibility".
Waste framework directive (2008/98/EC)

- The Directive lays down some basic waste management principles: it requires that waste be managed:
  - without endangering human health and harming the environment, and in particular **without risk** to water, air, soil, plants or animals
  - without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest.
Conclusions – Historic development

- Waste (sludge) legislation much later than waste water treatment legislation (as everywhere)
- Agricultural use:
  - preferred disposal method for many years in 20\textsuperscript{th} century
  - complemented by landfill disposal of dewatered sludge;
  - Main concern in Europe: long term metal accumulation in the soils
Conclusions – Historic development

- Consequence: strict limits for heavy metal discharge to sewer system, (Vienna: 1973: Hg and Cd in the range of 60 to 80 mg/kg DS, today below 1 to 2)
- The EU sludge Directive 271/86: developed by waste water, agricultural and soil experts (not from waste management)
- Amendment of this directive failed despite several attempts (30 years)
Conclusions – Historic development

• EU sludge directive still useful for sludge management and application on land (even the standards are not any more up to date)

• Since 2008: sewage sludge is a waste according to EU Waste Framework Directive 2008/98

• background and historic development different from water legislation
Conclusions – Historic development

• Transformation of sewage sludge to a market product like in US failed on EU level (except for compost and UK).

• In US: hygienic aspects most relevant

• In EU: strict bans or procedures for certain applications in agriculture

• Sludge application as fertiliser: Phosphorus is limiting sludge dosage (1 to 2 t DS/ha/a) to avoid P-accumulation in soils
Conclusions – actual situation

• National sludge strategies in Europe extremely diverse and on province level (Länder).

• Actual trends between total ban of applying sludge on land (CH, D, BW+NRW) and “forced” application.

• Hygienic aspects get more relevant again:
  – infection transfer at farm level (MCD, etc.),
  – transfer of antibiotic resistance, legionella?
  – even there is no report on hygienic problems with sludge application in agriculture over the last decennia.
Conclusions – actual situation

- Waste legislation (risk management) does not favour use of sludge in agriculture
- Increasing trend to recognise sludge (and WW) as valuable resources. (Water, P, N, org. C,..)
- 80 to 90% P-removal at most of the treatment plants in central Europe (having no P-ores)
- P-recycling is a matter of intensive research in EU.
- EU commission is preparing a P-policy
Conclusions – actual situation

• Landfill disposal of organic material is banned in several member states in EU (waste legislation) for groundwater protection, leading to

• increased application of sludge incineration (in most cases co-incineration with coal, solid waste, cement) and ash disposal.

• Ash as a raw material for P-industry is most promising for P-recovery and recycling
Conclusions – actual situation

• Intensive agriculture with animal breeding (imported feed) and biogas residues are in competition with sludge application on land (CH, NL, D, etc.) in order to avoid over-fertilisation.

• Consequence: great diversity of regional solutions caused by very specific local (regional) developments over the last decennia.
Conclusions – future trends

• Water and waste legislation meet on site of WWTP and cause conflicts,

• A consolidated resource management policy could offer the chance to define clear mid- and long term goals for water quality, waste- (including sludge-) soil-, energy- and climate gas management.

• In Europe Phosphorus management should be included in a new mid term resource management policy
Conclusions – future trends

• Large cities (WWTP > 100,000 pe): incineration:
  – reliability of sludge disposal (storage)
  – No risk with pathogens, micro-pollutants, nano-particles
  – odour prevention
  – cost minimisation favours co-incineration,
  – P-recovery favours mono-incineration (with animal meal)

• WWTP < 100,000 in rural areas: sludge in agriculture
  – Low cost
  – Full P (N and org. C) -recovery (high storage capacity)
  – Low operational skills (low technology level)
  – relationship to farmers
Conclusions – future trends

• Future Sludge management:
  – material balance concept on river basin level
  – source abatement for priority (hazardous) substances
  – point and diffused sources management (WWT and agricultural practice)
  – WW and sludge management with resource recovery.

• Harmonisation of water and waste management legislation and administration
Actual Austrian Approach

- ~55% of sewage sludge is incinerated with ash disposal (Vienna)
- ~30% is managed by waste industry (compost, land application, restoration)
- <15% are used in agriculture in accordance with provincial legislation
- ÖWAV: „Strategy paper on valuable compounds in sewage sludge“: mid term goal is to recover (recycle) most of the phosphorus in waste water (~40% of P-import).