Pollutants of emerging concern

UWWTD Evaluation and Fitness Check of the WFD and FD - Workshop on emerging pollutants

Introduction by the project team

The project team

- Wood is leading an EU-wide group that includes IEEP, COWI, National Technical University Athens, HR Wallingford and Cenia

Timeline

UWWTD Evaluation

- Publication of the Roadmap
- Start of the support project
- Open public consultation
- Expert workshops
- End of the project
- DG Environment publishes its evaluation document

Fitness Check

- Publication of the Roadmap
- Start of the support project
- Open public consultation
- Other stakeholders engagement
- End of the project
- DG Environment publishes its Fitness Check

Objectives of the workshop

- Present our findings in relation to pollutants of emerging concern
- Ask for your expert views and feedback on these
- Present the remaining gaps and areas for which we need more information
- Ask for your expert knowledge contributions during discussion slots
- Ask for any other source of evidence / information that would be useful for the studies (both UWWTD or WFD and FD).

Scope of the workshop

- Starting point is the fact that chemical substances in waste water are a source of concern
  - How much of these substances are there (detection / monitoring)?
  - How have these substances made their way into the waste water (path?)
  - How can these substances be removed (treatment techniques)?
  - Once removed from the water what happens to the sludge, is it not only moving the issue one step forward?
  - Is the overall legislative framework supporting the protection of the aquatic environment from pollutants of emerging concern?

‘Guidelines for the workshop

- All sessions include a presentation by the project team and interventions from speakers followed by Q&A time
- Time keeping
- The workshop attendance is based on ‘expertise’ related to the topic
- ‘Backward looking’ -> Evaluation methodology

After the workshop

- Presentations from speakers and team will be made available to participants

- Concise notes from the meeting will be provided to DG Environment, more detailed notes to be used for the analysis and projects.

- If you want to discuss further any issue presented / provide any reference, get in touch with the project team: UWWTDEVAL@woodplc.com

Pollutants of emerging concern – pathways into water

Session 1 - Pollutants of emerging concerns and mixtures in surface and groundwater – nature and extent of the problem

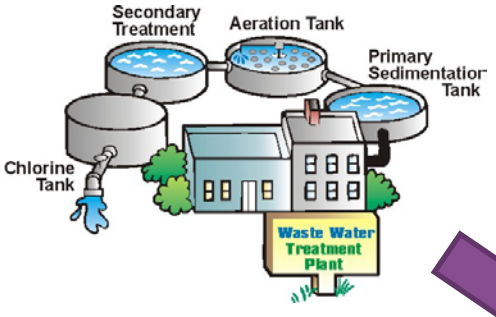
Dr. Robert Whiting

Overview of the presentation

Welcome to Session 1!

- Legislative overview for chemicals and water
- What do we mean by emerging?
- What are the common traits and patterns that lead to an emerging concern?
- Differences in impacts for surface and ground water?
- What kind of horizon scanning can be completed to identify issues?
- Gaps for UWWT plants?
- Case study example

Legislative framework



Urban waste water Treatment directive

Industrial emissions directive;
REACH;
Biocidal products regulation;
European – Pollutant Release and Transfer Regulation

Sewage sludge Directive;
Nitrates Directive;
Plant Protection Products Directive

Water framework Directive;
Ground water Directive
Environmental quality standards Directive

Drinking water Directive

Legislative framework

Water Framework Directive: Defines 'good chemical status', creates a need for monitoring of chemicals (River Basin Specific Pollutants) in surface waters reported through RBMPs.

Priority substances set up in Annex XV

Environmental Quality Standards Directive: Set framework for priority/priority hazardous substances for EU and critical thresholds not to be exceeded for 'good chemical status'

Ground Water Directive: Requirement to protect against deterioration of quality against named parameters, which includes chemicals and need for monitoring.

Drinking Water Directive: sets safe parameters for drinking water, including named chemical substances and thresholds that should not be exceeded.

Urban Waste Water Treatment Directive: Requirement to collect and treat wastewater for nutrient and pathogen content. Requirement to treat to meet COD requirements. Other chemicals not specifically included.

Sewage Sludge Directive: sets safe parameters for sludge, including named chemical substances (all metals) and thresholds that should not be exceeded. This includes accumulative effects of applying sludge to agriculture.

What do we mean by “emerging”?

The EQSD states:

“Monitoring data are particularly lacking for many emerging pollutants, which can be defined as ***pollutants currently not included in routine monitoring programmes at Union level but which could pose a significant risk requiring regulation, depending upon their potential ecotoxicological effects and on their levels in the aquatic environment****”*

What do we mean by “emerging”?

The source for different pollutants of emerging concern can come from a diverse range of applications and pathways to environment, but there are commonalities:

- Particularly potent or effective at their given application. This tends to mark them out from other chemicals so that they become the preferred choice.
- Usage tends to grow over several years to the point that large quantities are in use.
- Chemical properties, either intentionally by design or unintentionally as a by-product of their performance are highly resistant to degradation by physical pathways (light, air, water), chemical pathways, or biological action.
- Chemical properties that means that substances degrade to other toxic substances, or have a toxic effect because they are continuously released
- A pathway exists to environment, either from direct use, or commonly an indirect pathway, including via UWWT plants.
- Toxicity was not considered a problem when they were original manufactured and put into use. i.e. no acute toxic effects.

What do we mean by “emerging”? In Summary

- 1 Substances where for a long time society was unaware of the risks – because we thought they were safe.
- 2 Because society was unaware for a long time no one looked, or completed monitoring to assess effects, allowing them to accumulate.
- 3 Lack of analytical methods for detection potentially missing, which exacerbates the development of a weight of evidence.
- 4 No connection was made between pollutants and effects until only recently.

Legacy issues and impacts for UWWTPs

Legislation like REACH, BPR and PPP identify and ban use of chemicals that have an impact for environment.

However, legacy issues can create problems for many years after a ban.

E.g. DecaBDE began phase-out in 2013. However, goods treated with DecaBDE have a lifespan of 10-15 years. So much DecaBDE has been used that could create issues for UWWTPs as far out as 2030.

Surface water

- Major receiving environment for chemical pollution, both point sources and diffuse emissions.
- Possibility to create chronic effects within aquatic ecosystems, such as:
  - Altering the biodiversity of the ecosystem, where some species are lost.
  - Altering the function and behaviour of higher tier species negatively, which can have recursions for the food chain. Particular reproduction and predatory behaviour.
- Bioaccumulation of chemicals which affect all levels of the ecosystem, but particularly higher tier species.
- Movement of chemical species from the surface water compartment into other compartments having further knock-on effects (i.e. ground water).

Ground Water

- Potential to concentrate within the ground reaching higher concentrations.
- Lag time – delay before problem can be apparent but also for solutions to be effective
- Breakdown pathways are less effective, meaning that recovery times for ground water can be slower than surface water. Chemical species dependent.
- Potential to contaminate ground water resources used for abstraction and drinking water
- Potential for uptake into plant life and re-entry into the food chain
- Impact on Groundwater Dependent Terrestrial Ecosystems
- Potential create toxic effects which affect the plant life and other fauna living in the soil reducing capacity for agriculture.

Extent of the problem

The NORMAN network has identified 700 possible emerging pollutants in the natural environment grouped into 6 broad classes:

Class	Typical examples	Pathway
Pharmaceuticals	Painkillers, anti-depressants, anti-biotics, birth control, steroids, anti-inflammatories	Food chain via UWWT plants Direct to sewer as unused medicines or residues from hospitals
Industrial chemicals	Perfluorinated compounds, plasticizers, flame retardants	During manufacturing to sewer. Consumer goods – residues to sewer. Food chain via UWWT plants
Consumption products	Detergents, personal care products, fragrances, sun-screen	Consumer goods – residues to sewer. Food chain via UWWT plants
Pesticides	Insecticides, herbicides, fungicides	Diffuse agricultural emissions. Direct sewer amenity products
Biocides	Antimicrobial products	Residues washed to sewers from domestic, and commercial sites
Nanomaterials	Carbon Nano-tubes, titania	Manufacturing and industry sources. Consumer goods – residues to sewer.

Screening criteria for horizon scanning

The main models used by ECHA (under REACH for SVHCs), the JRC (for priority substances) and EFSA (for food), have all identified the same basic criteria to help identify what might be emerging chemical concern of the near future:

1) High tonnage of use.

2) Used in a wide dispersive fashion, or in applications direct to environment

3) Environmental monitoring to validate the points above

4) Assessment for adverse effects:
   - PBT characteristics?
   - CMR characteristics?
   - EDC characteristics?

Screening criteria for horizon scanning

Based on the screening criteria the main group of chemicals that are likely to be highest on the concern list are:

HIGH TONNAGE USE PESTICIDES

But is this really also the case for those chemicals related to UWWTPs?

Is tonnage on its own sufficient?

Pollutants of emerging concern for UWWT plants

Screening criteria and commonalities correlate well. With one exception. UWWTPs are not considered 'wide and dispersive' or 'direct to environment'

Based on aggregated emission data for water. The E-PRTR identified UWWTPs as either the single biggest or second biggest point source for all emissions to water depending on chemical group.

In particular chlorinated organic chemicals are dominated by releases from UWWTPs.

Pollutants of emerging concern for UWWTPs

Micropollutants – such as polyfluoroalkyl substances (PFAS). PFAs are very powerful surfactants, with few alternatives meeting similar performance. Highly resistant to physical, chemical, biological degradation. Use in Europe increased over c.50 years, including industrial and consumer applications (stain repellents).

Microplastics – very tough and resistant to all forms of degradation which made them a preferred choice for personal care products. Use of plastic generally has grown dramatically since 1950s. Prime source of microplastics in UWWT flows is from clothing and treated textiles, with personal care products and detergent aids secondary major sources.

Pollutants of emerging concern for UWWTPs

Pharmaceuticals – The EU is second largest user of pharmaceuticals globally (after the USA). Degradation rates vary hugely across the family of chemicals, but highly effective treatments have been popularised and use has grown dramatically. i.e. contraceptive pill (estradiol), painkillers (diclofenac), anti-depressants (fluoxetine), anti-biotics (macroloid anti-biotics like clarithromycin).

Case study – Microplastics

Primary :intentional use, including personal care products, dishwasher aids, detergents, abrasives.

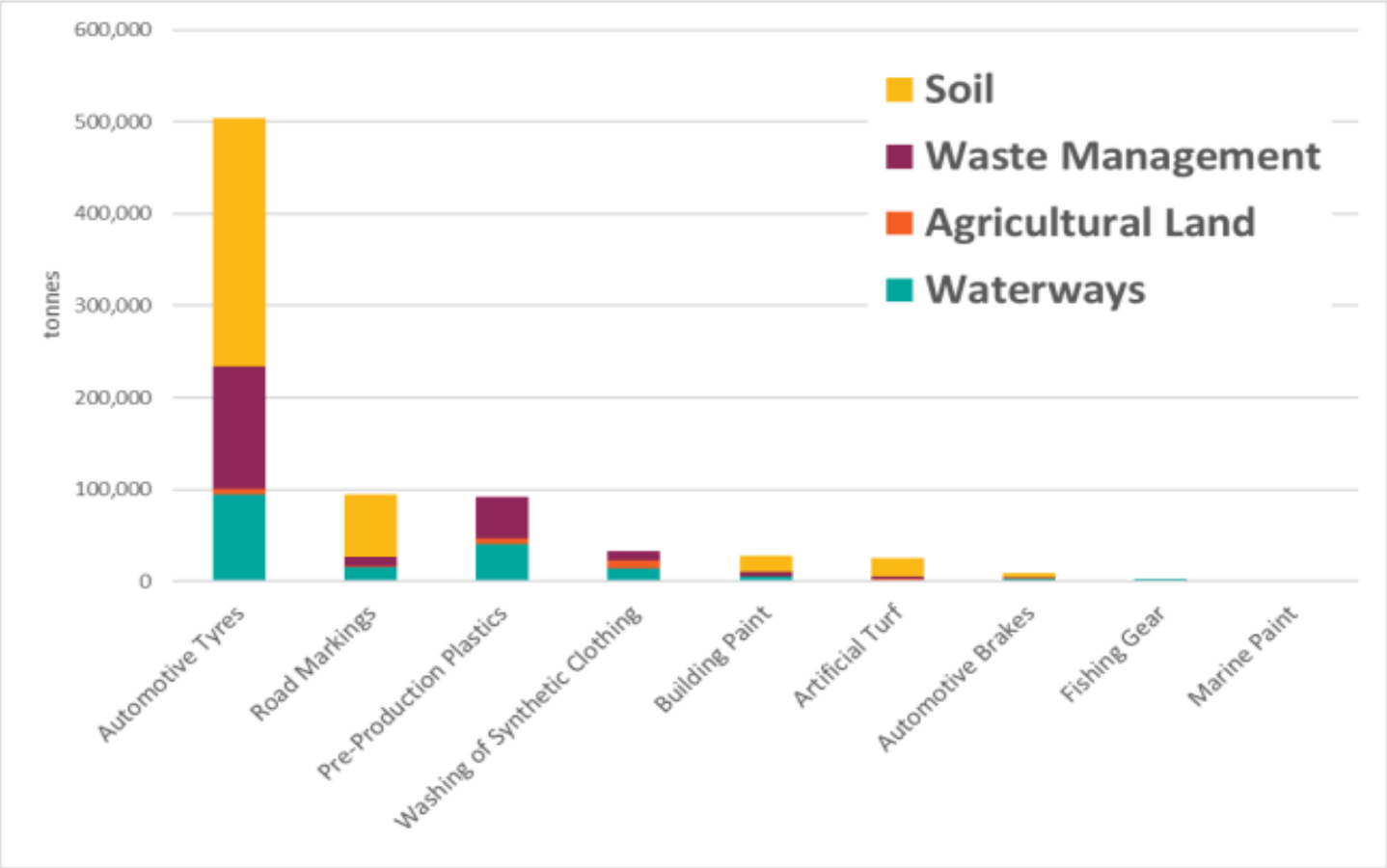
Secondary: unintentional from degradation from larger plastic items, such as brake & tyre wear, packaging waste, and other moulded plastic articles.

Environmental sources vary, emissions from UWWT plant do not match open-air sources

Importance of primary treatment in UWWTPs, where 90% of microplastics are partitioned into sludge

Concentrations in aquatic environment are affected by both open sources and UWWTPs

Casestudy - Microplastics



Eunomia, 2018, 'Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products

Casestudy - Microplastics

Why Microplastics are identified as a concern:

- Microplastics pose both a biota and human health risk:
  - capable of concentrating persistent organic pollutants.
  - capable of acting as carriers for pathogens, that can attack both humans and fish
  - physical hazard (i.e. blocks the guts of aquatic species)

- Lancet (2017) global samples of drinking water found detectable concentrations of MPs in 83% of samples. Also detected in samples of consumer products such as beer, and air samples from Paris.

Summary

- Broad legislative framework, but with possible gaps in how chemicals are managed.
- Pollutants of emerging concern can be difficult to identify, and typically relate to chemicals that have been in use for a number of years because we thought them safe.
- Effects for surface water and ground water are different.
  - Surface water direct ecotoxic effects on aquatic life.
  - Ground water can concentrate chemicals, slow to recover, affects abstraction and drinking water.
- Potentially wide ranging issues, the NORMAN network identify 700 possible grouped into six main categories.
- UWWTPs are a major source of releases to surface water. The consumer population, and use of chemicals in the consumer domain being important for potential EPs

Monitoring in surface and groundwater

Dr Friederike Vietoris (Ministerium für Klimaschutz, Umwelt, Landwhaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, DE)

Q&As

- Any questions?
- Further information we would like to ask:
  - What information do you have on emission profiles of the substances considered, what is the level of awareness on how these substances get in waste water?
  - Do you have any information on the magnitude of the (perceived) problem paused by these substances (i.e. quantitative information)?
  - How significant are UWWTP emissions as a source of these substances in the environment compared with other sources, and what evidence is there that upgrades to UWWTPs have reduced emissions and benefited the environment?

Session 2 - Pollutants of emerging concern and the water legislation

Victoria Cherrier

Overview of the presentation

- EU legislative framework and pollutants of emerging concern
  - Is it already tackled and how?
- Following the 6 categories of pollutants of emerging concern
- Sources / behaviour / pathways / fate of chemicals
- Objective – understand whether there is a gap

6 classes of pollutants of emerging concern

- **Pharmaceuticals**
- **Industrial chemicals**
- Consumption products
- **Pesticides**
- Biocides
- Nanomaterials

Pharmaceuticals

Class	Typical examples	Pathway
Pharmaceuticals	Painkillers, anti-depressants, anti-biotics, birth control, steroids, anti-inflammatories	Food chain via UWWT plants Direct to sewer as unused medicines or residues from hospitals
Industrial chemicals	Perfluorinated compounds, plasticizers, flame retardants	During manufacturing to sewer. Consumer goods – residues to sewer. Food chain via UWWT plants
Consumption products	Detergents, personal care products, fragrances, sun-screen	Consumer goods – residues to sewer. Food chain via UWWT plants
Pesticides	Insecticides, herbicides, fungicides	Diffuse agricultural emissions. Direct sewer amenity products
Biocides	Antimicrobial products	Residues washed to sewers from domestic, and commercial sites
Nanomaterials	Carbon Nano-tubes, titania	Manufacturing and industry sources. Consumer goods

Pharmaceuticals

- Environmental Pollution caused by human and veterinary pharmaceutical substances is an emerging environmental problem.
- Article 8c of Directive 2008/105/EC (amended by Directive 2013/39/EU) --> strategic approach to water pollution from pharmaceutical substances.
- Way into waste water through:
  - Manufacturing (up to 2%),
  - Consumption (between 30 and 90% of the orally administered dose is generally excreted as active substance in the urine of animals and humans)
  - Also surplus used in aquaculture
  - Incorrect disposal of unused medicine

Pharmaceuticals

- Legislative background
  - Some pharmaceuticals as part of the Watch List
  - Some pharmaceuticals identified as RBSP
  - Environmental Risk Assessment in the Market Authorisation (MA) process
  - Mostly exempted from REACH
  - IED regulates some intensive livestock rearing sites (above threshold) and pharmaceuticals manufacturing sites, but no pharmaceutical substance for which an ELV has been set through the BAT conclusions
  - EU Strategic Approach to Pharmaceuticals in the Environment

Industrial chemicals

Class	Typical examples	Pathway
Pharmaceuticals	Painkillers, anti-depressants, anti-biotics, birth control, steroids, anti-inflammatories	Food chain via UWWT plants Direct to sewer as unused medicines or residues from hospitals
Industrial chemicals	Perfluorinated compounds, plasticizers, flame retardants	During manufacturing to sewer. Consumer goods – residues to sewer. Food chain via UWWT plants
Consumption products	Detergents, personal care products, fragrances, sun-screen	Consumer goods – residues to sewer. Food chain via UWWT plants
Pesticides	Insecticides, herbicides, fungicides	Diffuse agricultural emissions. Direct sewer amenity products
Biocides	Antimicrobial products	Residues washed to sewers from domestic, and commercial sites
Nanomaterials	Carbon Nano-tubes, titania	Manufacturing and industry sources. Consumer goods

Industrial chemicals

- Industrial process involves a range of chemical used through various stages of production / transport / distribution activities
- Quantity and toxicity of chemicals vary according to the industry
- Safety for the environment, safety of workers and general public

Industrial chemicals

- Legislative framework includes:
  - Industrial Emissions Directive

  BREF on Common Waste Water Treatment – chemical sector

  Other BREFs cover industrial sectors with potential pollutants of emerging concern, but ELVs for specific chemical substances limited
  - UWWTD covers certain industrial sectors

Pesticides

Class	Typical examples	Pathway
Pharmaceuticals	Painkillers, anti-depressants, anti-biotics, birth control, steroids, anti-inflammatories	Food chain via UWWT plants Direct to sewer as unused medicines or residues from hospitals
Industrial chemicals	Perfluorinated compounds, plasticizers, flame retardants	During manufacturing to sewer. Consumer goods – residues to sewer. Food chain via UWWT plants
Consumption products	Detergents, personal care products, fragrances, sun-screen	Consumer goods – residues to sewer. Food chain via UWWT plants
Pesticides	Insecticides, herbicides, fungicides	Diffuse agricultural emissions. Direct sewer amenity products
Biocides	Antimicrobial products	Residues washed to sewers from domestic, and commercial sites
Nanomaterials	Carbon Nano-tubes, titania	Manufacturing and industry sources. Consumer goods

Pesticides

- Pathway into water (agriculture / gardening):
  - During spreading
  - Leach through the soil,
  - Carried as runoff,
  - Accidental spill
- Pesticides in groundwater and surface water widely detected, range of substances reported in WISE as part of latest RBMP
- Expensive for waste water treatment to remove
- Repeated exposure can lead to physiological and behavioral changes in aquatic populations
- In 2016 almost 400,000 tonnes of pesticides sold

Pesticides

- Legislative framework
  - Sustainable Use of Pesticides Directive 2009/128/EC
  - WFD – some listed as river basin specific pollutants, some listed as priority substance and watch list
  - Drinking Water Directive for content of pesticides in drinking water
  - EFSA evaluates active substances used in plant protection products and Member States evaluate and authorise the products at national level.
  - Plant protection products are regulated by framework Regulation (EC) No 1107/2009.
    - 2017 report on implementation called for more data to quantify the risk and the level of pesticide pollution. "Data needs are the EU Biodiversity Strategy 2020, the common agricultural policy (CAP), the Water Framework Directive, and the Thematic Strategy on Soils".
  - Pesticide residues in food and feed are covered by Regulation (EC) No 396/2005.
  - EU Pesticides Database:

Beyond substance specific

- Effect of mixtures of substance?

Chemicals in waste water modelling

Dr Alberto Pistocchi (Joint Research Centre, EC)

Tackling micropollutants in Switzerland

Aline Meier (Micropoll Swiss Water Association, CH)

Q&As

- Any questions?
- Further information we would like to ask:
  - For the categories of emerging pollutants presented, do you have any further view on gaps / coverage of the legislative framework.
  - Have any Member States issued permits for UWWTPs that set emission limit values for any of these pollutants (or considered doing so)? On what basis have they been set, and have they been easily met?
  - What (alternative/complementary) source-control measures are being taken in relation to these substances, and how effective are they?
  - What is the level of public awareness of this type of pollutant and how they enter UWWTPs?

Dealing with pollutants of emerging concern in waste water

Session 3 - Treatment options for pollutants of emerging concern

Dr. Robert Whiting

Overview of the presentation

Welcome to Session 3! Which deals with treatment options.

- Sources of pollutants of emerging concern to waste water
- The scale of the issue facing the wastewater treatment industry
- Standard treatment options – effect on pollutants of emerging concern
- How WWTPs options can effect emission pathways
- Current tertiary treatment options

Sources of pollutants of emerging concern in waste water system

- Use of pharmaceuticals – The EU is the second largest user of pharmaceuticals globally (behind the USA).
- Use of personal care products, detergents, dishwasher chemicals – The use of chemicals intentionally washed to drains, this has included microplastics.
- Use of chemicals designed to withstand degradation (particularly heat resistant) – PFOS, PFOA, PFAS were all used as stain repellents for domestic textiles, kitchenware and interior design products. Bisphenol A and PBDEs both fire-retardants.
- Traffic emissions – Deposition and runoff into CSO and sewer systems is an important sources of PAHs and metals.
- Domestic use pesticides – Potential for home use pesticidal products to either be poured to drain as a waste option.
- Industrial sources – Some industrial manufacturing is highly water dependent and has permitting in place to release to sewers.

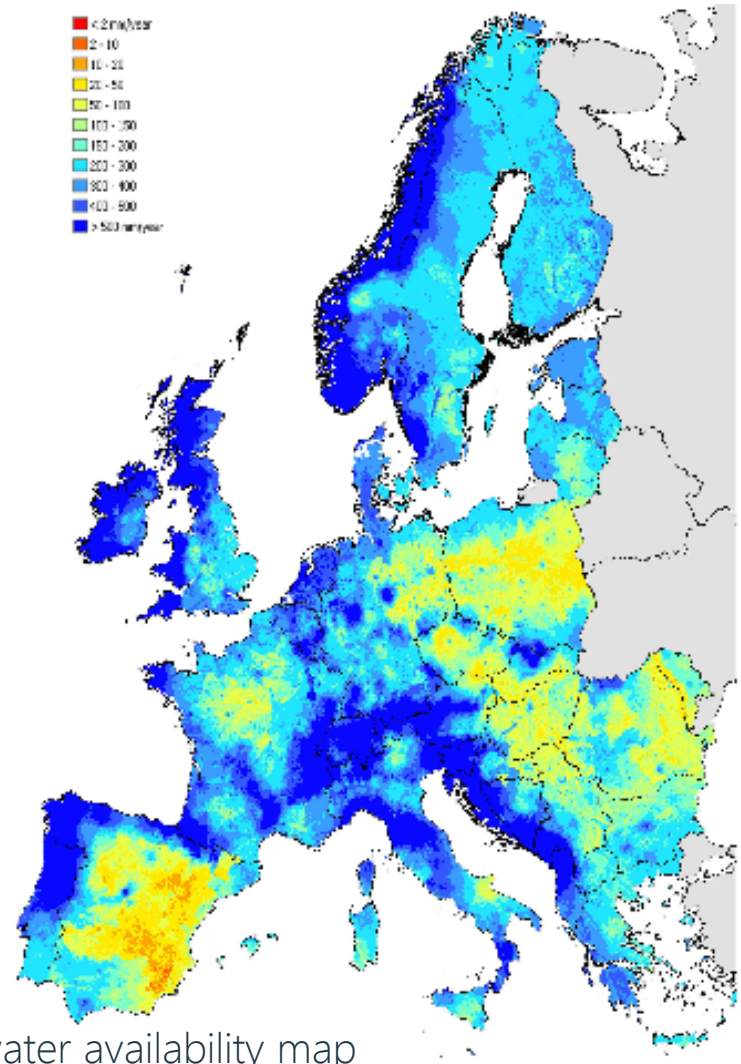
Scale of pollutants of emerging concern in waste water system

Water demand in the EU is predicted to increase by 16% by 2030.

There is increasing pressure on EU WWTPs to process large volumes of waste water quickly and efficiently in order to get it back into circulation.

Diverse nature of chemical pressures on WWTPs means that no 'heal all' technology exists.

Suites of different techniques are needed, or targeted approach depending on pressures identified.



JRC, water availability map

Standard treatment options and pollutants of emerging concern 1

Primary: (mechanical process) Separation and removal of solids from raw effluent.

Secondary: (biological process) treatment uses aerobic or anaerobic microorganisms to decompose most of the organic matter and retain some of the nutrients (around 20-30 %).

Tertiary: (advanced) anything above and beyond primary and secondary treatment options.

Standard treatment options and pollutants of emerging concern 2

PBTs

e.g. PAHs, PCBs, POP-pesticides

Physical properties: non-soluble, highly persistent, highly stable to thermal, oxidative, or chemical degradation.

Within WWTPs: primary treatment partitions into sludge. Dewatering concentrates. Binds tightly standard techniques ineffective.

PMTs

e.g. PFOS, PFOA, PFAS

Physical properties: Highly soluble, highly persistent, highly stable to thermal, oxidative, or chemical degradation.

Within WWTPs: primary treatment partitions mainly to effluent. Secondary treatment ineffective as PFAs are resistant to biological degradation.

Microplastics

e.g. <5mm diameter

Physical properties: insoluble, lighter than water, persistent, highly stable to thermal, oxidative, biological or chemical degradation.

Within WWTPs: 90% partitions into sludge at primary treatment, all other sludge treatment techniques ineffective. Effluent techniques ineffective as resistant to biological treatment.

Pharmaceuticals

e.g. diclofenac, estradiol, statins, antibiotics

Physical properties: varies hugely, many possible degradation pathways, possibility for AMR build up.

Within WWTPs: can end up in both effluent and sludge, will degrade, but concentrations from human population means not fully effective. Some pharmaceuticals survive WWTPs better than others.

The role of sludge

Depending on solubility, lipophilic tendencies and physical form, primary treatment has a key role for partitioning chemicals between liquid phase and sludge. So for example:

- Microplastics – >90% partitioned to sludge
- Micropollutants – variable. For some e.g. PCBs >90% partitioned to sludge, for others e.g. PFAs <40% partitions to sludge
- Pharmaceuticals – variable, most pharmaceuticals are readily soluble with
- <50% partitioning to sludge. Minimum <5% for some antibiotics, Maximum 80%+ partitioned into sludge.
- Metals – >90% partitions into sludge but can vary (Co, Cu, Ni, and Zn more soluble. As, Cd, Cr, Hg, and Pb all resorbed very highly into sludge, little or none left in wastewater).
- Pesticides – variable, but many come as oil based emulsions and so >50% partitioning into sludge is possible.

Types of tertiary treatment for pollutants of emerging concern

All tertiary treatment can be grouped into two broad categories:

1) Types of physical / chemical processes designed to remove chemicals from waste flows. These can then be managed separately as a new waste stream.
   e.g. Granulated activated carbon (GAC), Nano-filtration, catalytic retrieval of metals

2) Types of physical / chemical processes designed to destroy chemical species in situ.
   e.g. Advanced Oxidative Processes (AOP), nitrification/denitrification, enhanced biological treatment

Types of treatment for removal of chemicals

Basic examples:

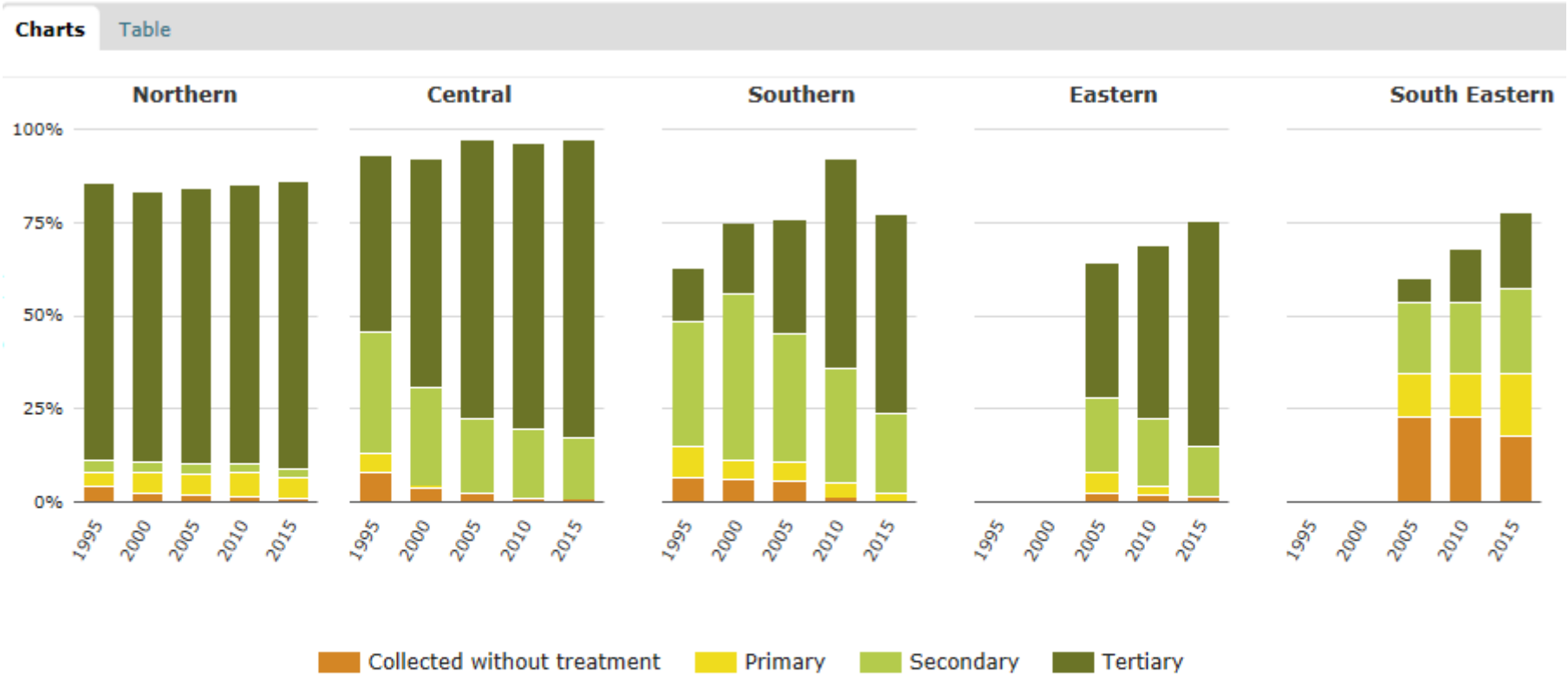
- GAC/PAC: the use of activated carbon to 'adhere' chemical species to the surface of the carbon for later removal and destruction.
- Nano-filtration: Effective in particularly against microplastics, but very limited effectiveness against pharmaceuticals.
- Catalytic retrieve: Use of catalytic processes to remove chemicals from water/sludge. Particularly effective for metals, but limited scope for other chemical species.

Types of treatment for destruction of chemicals in situ

Basic examples:

- AOP and Pulse technology: Use of advanced oxidative photo catalysis to break chemical bonds and destroy chemical species within waste water.
- Nitrification/denitrification: use of nitrifying and denitrifying compounds to undergo substitution reactions to break chemical bonds and destroy chemical species.
- Enhanced biological treatment: Enriched bioactive sludge, used to boost the generation of biomass and biological action against chemical species.

Uptake of Tertiary treatment



Note:
Northern Europe: Norway, Sweden, Finland and Iceland.
Central Europe: Austria, Belgium, Denmark, Netherlands, Germany, Switzerland, Luxembourg and United Kingdom.
Southern Europe: Greece, Italy, Malta and Spain.
Eastern Europe: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland and Slovenia.
South-eastern Europe: Bulgaria, Romania and Turkey.

*reference: European Environment Agency

Uptake of Tertiary treatment

The UWWTD requires additional treatment for what are termed ‘sensitive areas’.

- Much of the additional tertiary treatment appears to focus primarily on controlling N and P in sensitive areas
- Complete breakdown on types of treatment and targeted use not available.
- GAC has been most popular to date with emergence of AOP as a popular alternative.

*reference: European Environment Agency

Summary

- Standard primary and secondary treatments largely ineffective against chemicals.
- However, primary and secondary treatment can effect emission pathway.
- Chemicals entering sewers come from diverse sources, and have diverse properties but are all linked to anthropogenic activities.
- Pressure on WWTPs to treat quickly and effectively.
- Most tertiary treatments either remove or destroy in situ.
- New and effective technologies do exist, but no one 'heal-all' option. Careful selection and placement needed.

Monitoring and removal of micropollutants in waste water

Dr Ola Svahn (Kristianstad University Sweden)

Waste water treatment approaches in Germany

Dr Joachim Heidemeier (German Federal Environment Agency)

Study on removing microplastics from waste water

Bruno Barillon (Suez)

Q&As

- What is driving (or not) the uptake of tertiary treatment in your Member State?
- Are regulators and operators of waste water treatment plants able to communicate effectively on the issue related to pollutants of emerging concern?
- What have the costs been of upgrading UWWTPs to make them effective at removing pollutants of emerging concern?

Session 4 - Risks from pollutants remaining in the treated waste water or sludge

Dr Ian Keyte

Overview of the presentation

- ***Introduction and background***
  - Sewage sludge in Europe
  - Opportunities/challenges from sludge use
- ***Policy aspects***
  - Key legislation
  - Other policy aspects e.g. circular economy, REACH etc.
- ***Overview of key issues***
  - Emerging pollutants of concern
  - Key treatment issues and options
- ***Data gaps and remaining questions***

Background – What is sewage sludge?

- **'Sludge' defined as:**
  - *"residual sludge, whether treated or untreated, from urban waste water treatment plants" – UWWTD*
  - *Also "domestic or urban waste treatment plants, septic tanks and similar sewage treatment plants" – SSD*

- **'Treated sludge' means:**
  - *"sludge which has undergone biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use" – SSD*

Key legislation and policy aspects

- **Sewage Sludge Directive (SSD) (86/278/EC)**
  - Prohibits use of untreated sludge on agricultural land
  - Limit concentrations for 7 heavy metals in soil + sludge
  - Sets no limits for organic contaminants
  - Bans application of sludge to soil in which fruit and vegetable crops are growing
  - Restriction of when grazing animals can be allowed to access grassland .
  - Requirements for monitoring/sampling both sludge and receiving soils

Key legislation and policy aspects

- **Water Framework Directive** (WFD) & **Environmental Quality Standards Directive** (EQSD)
- **Urban Waste Water Treatment Directive** (UWWTD)
  - "Sludge arising from waste water treatment shall be re-used whenever appropriate. Disposal routes shall minimize the adverse effects on the environment"
  - Industrial waste water shall be subject to pre-treatment to "ensure that sludge can be disposed of safely in an environmentally acceptable manner.
- **Detergents Regulation**
  - Risk assessment includes testing to assesses potential for the release of surfactant chemicals by sewage treatment
- **Chemicals legislation** e.g. REACH, Biocidal, Plant Protection, Cosmetics, Medicines etc
  - Prevent/restrict harmful chemicals entering waste streams

Opportunities and Challenges of sewage sludge application on land

Opportunities	Challenges
• Agricultural application on land • Source of nutrients (e.g. P, N, K, S) and organic matter • Resource efficiency and conservation • Other applications e.g. energy / biogas production, anaerobic digestion • Recovery of precious metals e.g. Au, Ag, Pt	• Pollutants in sludge • Primary treatment transfers pollutants from waste water into the solid phase (sludge) • e.g. heavy metals, organic compounds and pathogens (viruses, bacteria etc.)

Chemical content of sludge

- JRC – FATE SEES 2012
  - Reviewed chemical content of sewage sludge
  - Examples from several Member States
  - Concluded that overall emerging pollutants was more of an issue for effluent than for sludge
  - Scope for lowering limits for HM, also for P and K
  - No indication that PCB, PCDD/F or PAH need specific limits
  - Sensors / bioassays might help gaining a better understanding of the situation
  - More information needed to have view of evolution

Treatment options – sludge

- Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use"

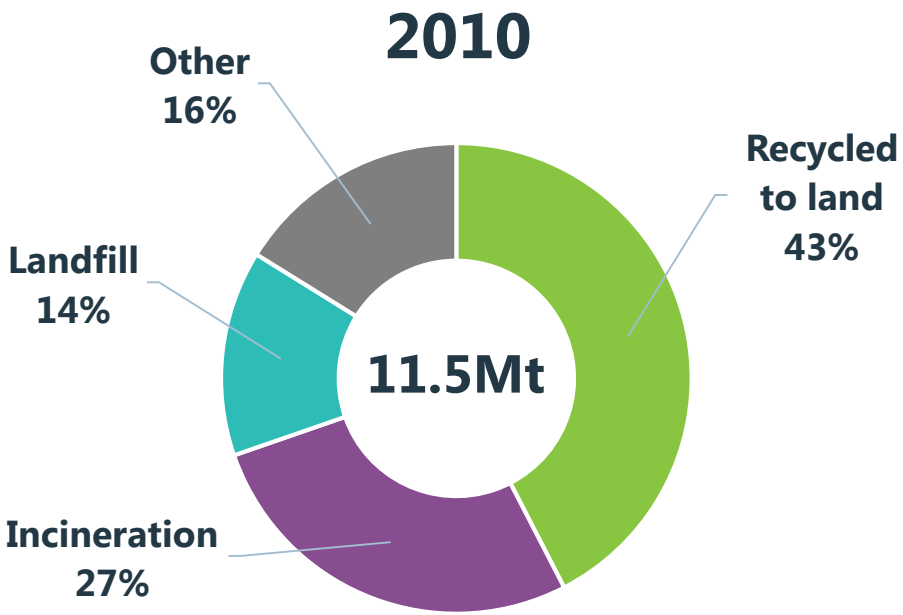
Organic content	Chemical
• Stabilistation (digestion) • Thickening • Dewatering • Drying / Lagooning • Digestion	• Phosphorus recovery • Thermal depolymerisation • Thermal hydrolysis

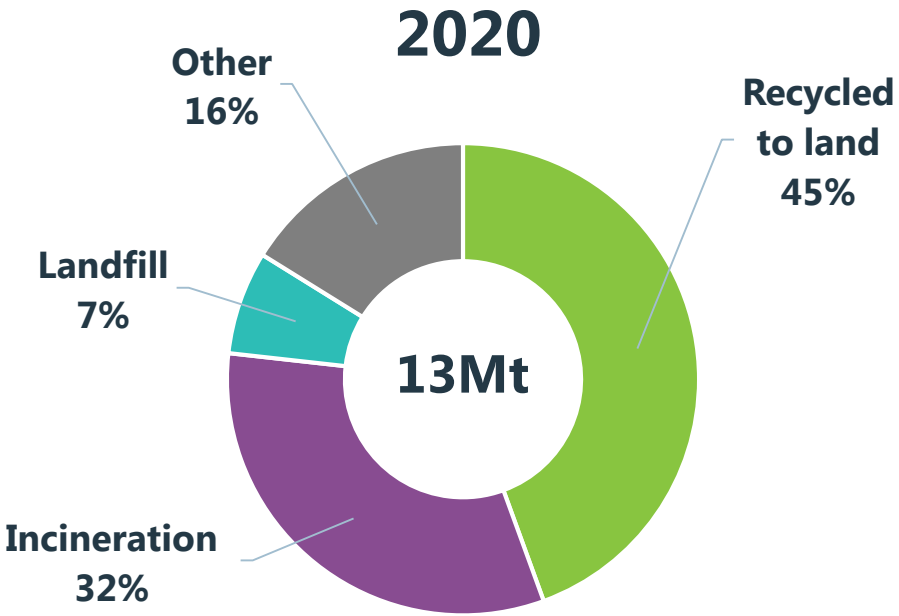
Treatment options – Waste water

Biological	Chemical
• Secondary treatment (activated sludge) • Nitrification/Denitrification • Absorptive media e.g. Activated Carbon	• Advanced Oxidative Processes (AOPs) • e.g. photo catalysts (e.g. TiO, ZnO) • Ozonation • Often used in the presence of peroxide (H_2O_2)

- Costs
- By-products
- Efficiency is site specific

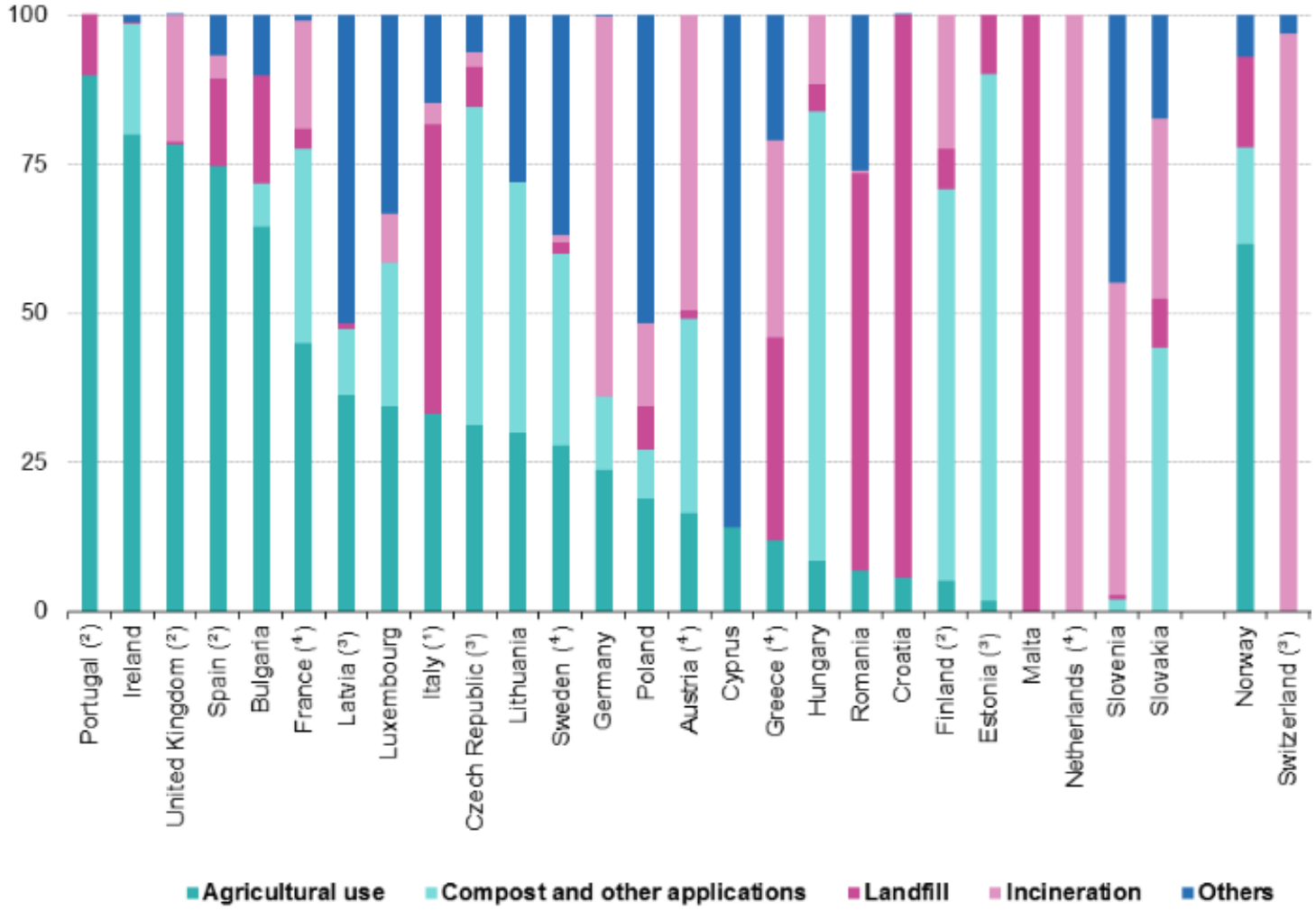
Sewage sludge disposal in Europe





Source : Milieu et al. (2009) Environmental, economic and social impacts of the use of sewage sludge on land

Sludge disposal routes



*Eurostat data from 2015

Emerging pollutants of concern for sludge

- **Emerging Priority Substances**
  - e.g. Metals and Pesticides, not included in SSD limits
- **Pharmaceuticals**
  - EU is the second highest user globally behind the USA
  - Issue of anti-microbial resistance (AMR) – low level exposure can allow harmful pathogens to build up resistance to antibiotics;
- **Microplastics**
  - Soil is a key environmental component
  - Up to 98% of microplastics partition into sewage sludge (Irish EPA)
  - Diverse range of source e.g. tyre/brake wear (500 kt) ; washing of clothes (100 kt) and difficult to characterize/apportion

Diverse set of chemicals with different physical / chemical properties

Key policies and their implications for sludge

- **Political context support the reuse of sludge**
  - **Circular economy strategy**
    - Strategy for improved reuse/recycling of wastes as a resource
  - **Fertilisers Regulation**
    - Revised EU regulation on fertilizers "to help develop an EU-wide market for bio-nutrients while ensuring safety and quality of the EU Fertilisers"
  - **Renewable Energy**
    - Renewable Energy Directive sets 20% renewables target by 2020
    - Sludge recognised as a sustainable source of biomass
  - **Plastics Strategy**
    - Encourage capture of micro plastics in waste water treatment plants

Possible coherence issues

- Primary treatment at WWTPs causing partitioning of pollutants out of the liquid phase into sewage sludge.

- Coherence between the UWWTD/WFD/EQSD/SSD :
  - UWWTD not addressing the issue directly
  - List of substances under SSD is narrow compared to the EQSD
  - Many MS have imposed stricter limits for pollutants (e.g. metals) than set under the Sewage Sludge Directive (SSD)
  - SSD does not specify treatment processes required
  - EQSD – may not include key emerging chemicals of concern in priority lists ; gaps are identified

Summary

- Following treatment – potential to transfer pollutants from liquid phase to residual solid sludge
- Options for treating sludge but not 'one solution'
- EU legislation – water, UWWT, chemicals, resource efficiency, renewable energy and others
- Key coherence issues
  - UWWTD does not address this issue
  - Narrow list of chemicals covered in SSD
- Emerging chemicals of concern e.g. pharmaceuticals, microplastics

The Norwegian experience

Pr Bert van Bavel (Research Director, NIVA)

Speaker 2: Anti-microbial resistance

Dr Joakim Larsson (University of Gothenburg, Sweden)

Q&As

- Has upgraded treatment resulted in more contaminated sludge, and how has this been dealt with?
- What treatment options for sludge? Is there a loss of opportunity or more opportunities created?

Session 5 - Emerging pollutants, a coherent framework?

Keir McAndrew

Overview of the presentation

- Beyond the scope of pollutants of emerging concern - possible coherence issues
- Is there a gap in the scope of the UWWTD?
- Coherence with the wider water legislative framework?

Relevant legislation includes

- The WFD and EQSD
- Nitrates Directive
- Bathing Water Directive
- Fertilisers Regulation
- Sewage Sludge Directive
- The Industrial Emission Directive (IED) (2010/75/EU)
- The Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) Regulation (1907/2006)
- Plant Protection Products Regulation (1107/2009)
- Biocidal Products Regulation (528/2012)
- Authorisation and supervision of medical products for humans and veterinary use (EC 726/2004)

WFD and EQSD

- The UWWTD does not specify any pollutants beyond nutrients (N and P) apart from control of parameters (BOD, COD).
- Is this creating a problem in addressing emerging pollutants in water?
  - The UWWTD does not have the same approach at 'naming and controlling' pollutants that is in the EQSD or through RBMPs in the WFD
  - The level of obligations placed is different (operators through permits vs Competent authorities)
- Limited evidence that there is a gap in the control of pollutants, but acknowledgment that knowledge on chemicals is more advanced than 20 years ago.

Nitrates Directive

- The two Directives were adopted at the same time, while UWWTD is important for nitrogen pollution it was not its main objective.
- The assessment of whether waters are sensitive areas or NVZs is a potential overlap.
- One area of interaction occurs when both WWTPs and agriculture are sources of nitrogen pollution to the same water body. Neither Directive addresses this interaction.
- ECJ case C-293/97 19.04.1999
- Problems in understanding trends due to inconsistencies across reporting periods
- No apparent issue of coherence

Bathing Water Directive

- Requirements to identify water bodies used for bathing
- State of Bathing Water analysis highlights that one source of pollution is sewage, from storm water overflows
- Principle source of the microbial contaminants which place bathing waters at risk is from human sewage

Overview of other legislations

- Fertilisers Regulation
- Sewage Sludge Directive
- Industrial Emission Directive
  - BREFs & BAT conclusions
  - Discharges of waste water
  - Chemical content of waste water for some activities
- REACH Regulation
  - Specification for authorisation and production of chemicals.
- Biocidal Products Regulation / Medical products legislation

Questions

- When considering the coherence of the overall legislative framework dealing with pollutants in waste water / water
  - Is there a gap?
  - What issues have we been able to identify and at which stages are these applicable: detection, monitoring, sampling, treatment, after treatment?