Environmental, economic and social impacts of use of sewage sludge on land

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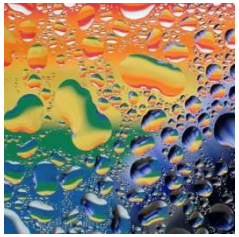


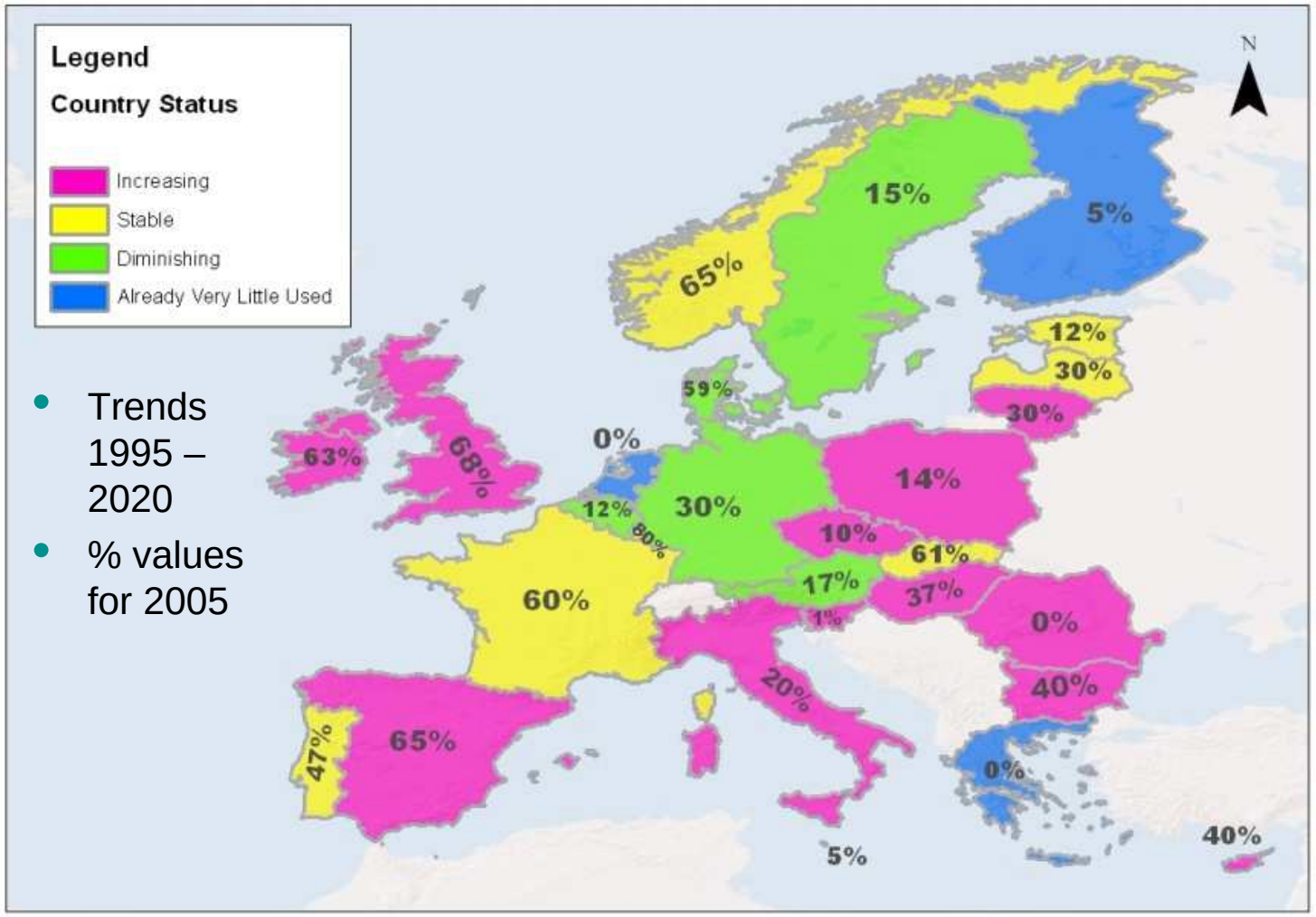
Study carried out for DG Environment by a consortium of WRc, RPA and Milieu, completed in April 2010

- Disclaimer – this presentation was derived from work carried out for the European Commission, but does not necessarily represent the position of the Commission

Use of sewage sludge on agricultural land

- The Sewage Sludge Directive (86/278/EEC) – robust and flexible regulation – provides for treatment, sludge and soil quality standards, and agricultural controls
  - Treatment requirements undefined
  - Metals limit values defined for sludge and soil (Cd, Cu, Ni, Zn, Pb, Hg, Cr)
  - Restrictions on time between application and land use
- “Double barrier” principle to protect human and environmental health

Sludge use on agricultural land



- Trends 1995 – 2020
- % values for 2005

What has changed since 1986?

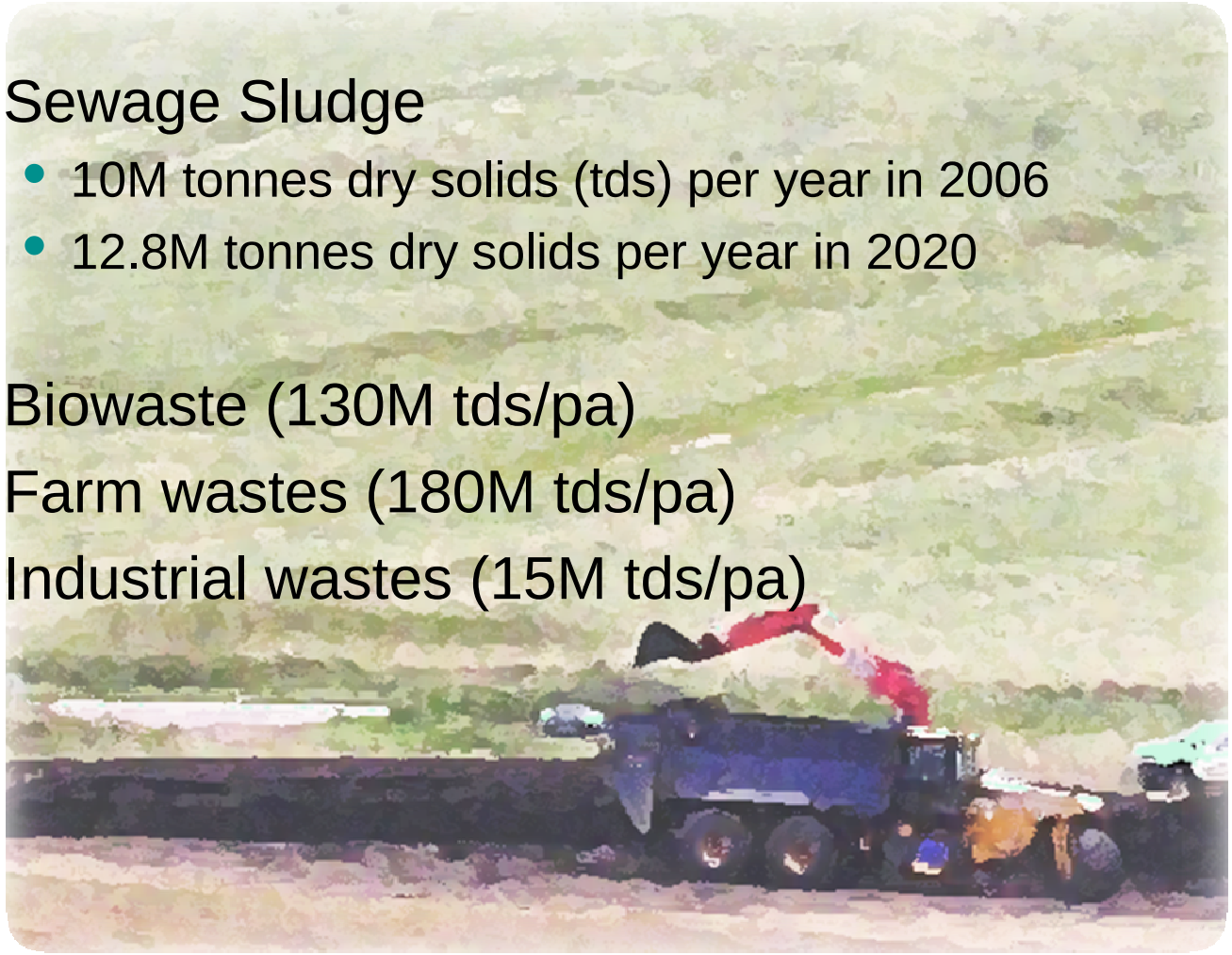
- Public concerns leading to different MS restrictions
- Other EU Directives

- Increased sludge in all MS (EU15 & EU12) due to:
  - Increased population (493m in 2007; 514m in 2020)
  - Increased sewage effluent quality requirements
  - Increased connections to sewers and treatment (to equivalent of 671m pe)

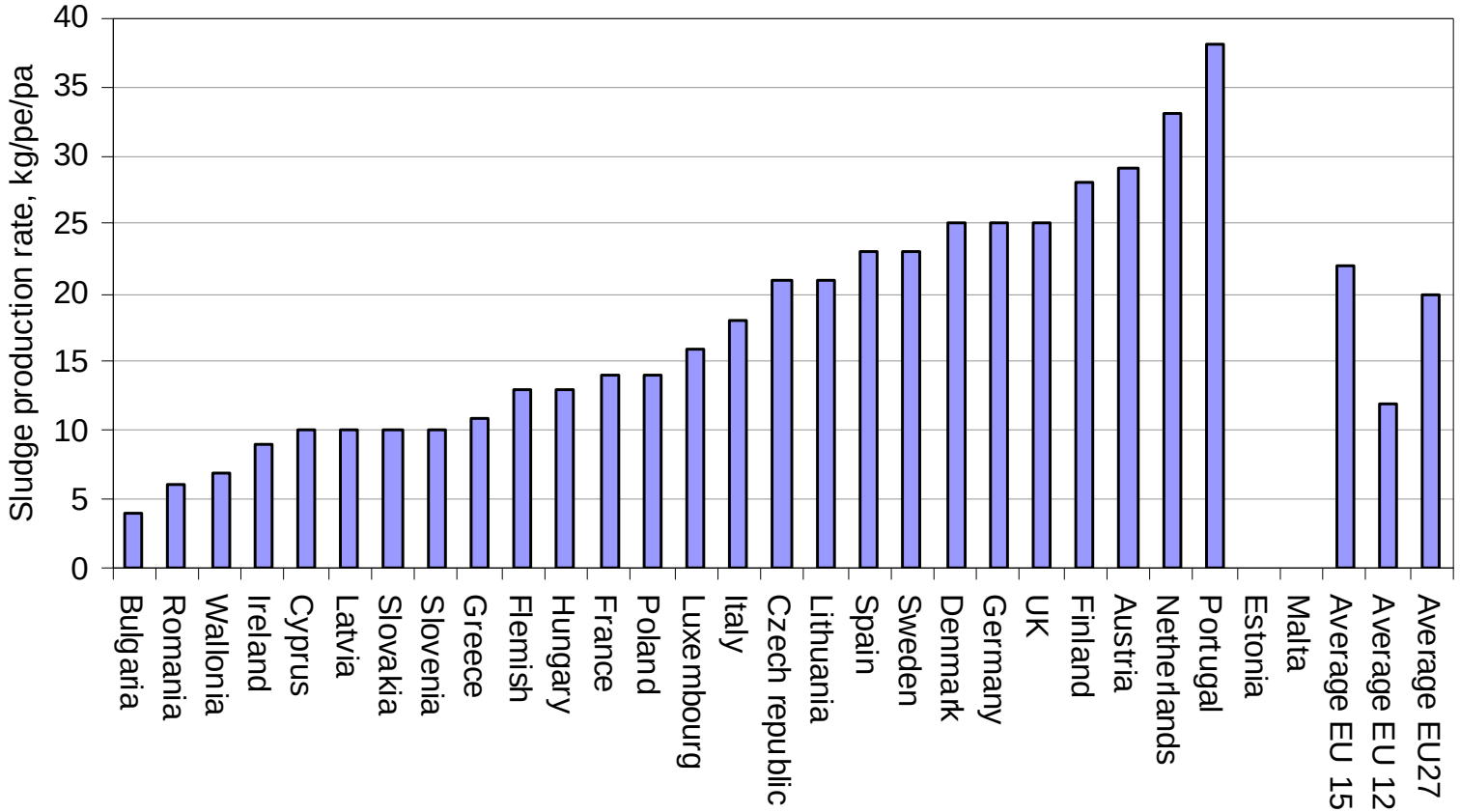
- Competition with other organic materials
- Reduced range of outlets (landfill limits, no sea disposal)
- Greenhouse gases and energy recovery now more important

Organic materials available in the EU

- Sewage Sludge
  - 10M tonnes dry solids (tds) per year in 2006
  - 12.8M tonnes dry solids per year in 2020
- Biowaste (130M tds/pa)
- Farm wastes (180M tds/pa)
- Industrial wastes (15M tds/pa)

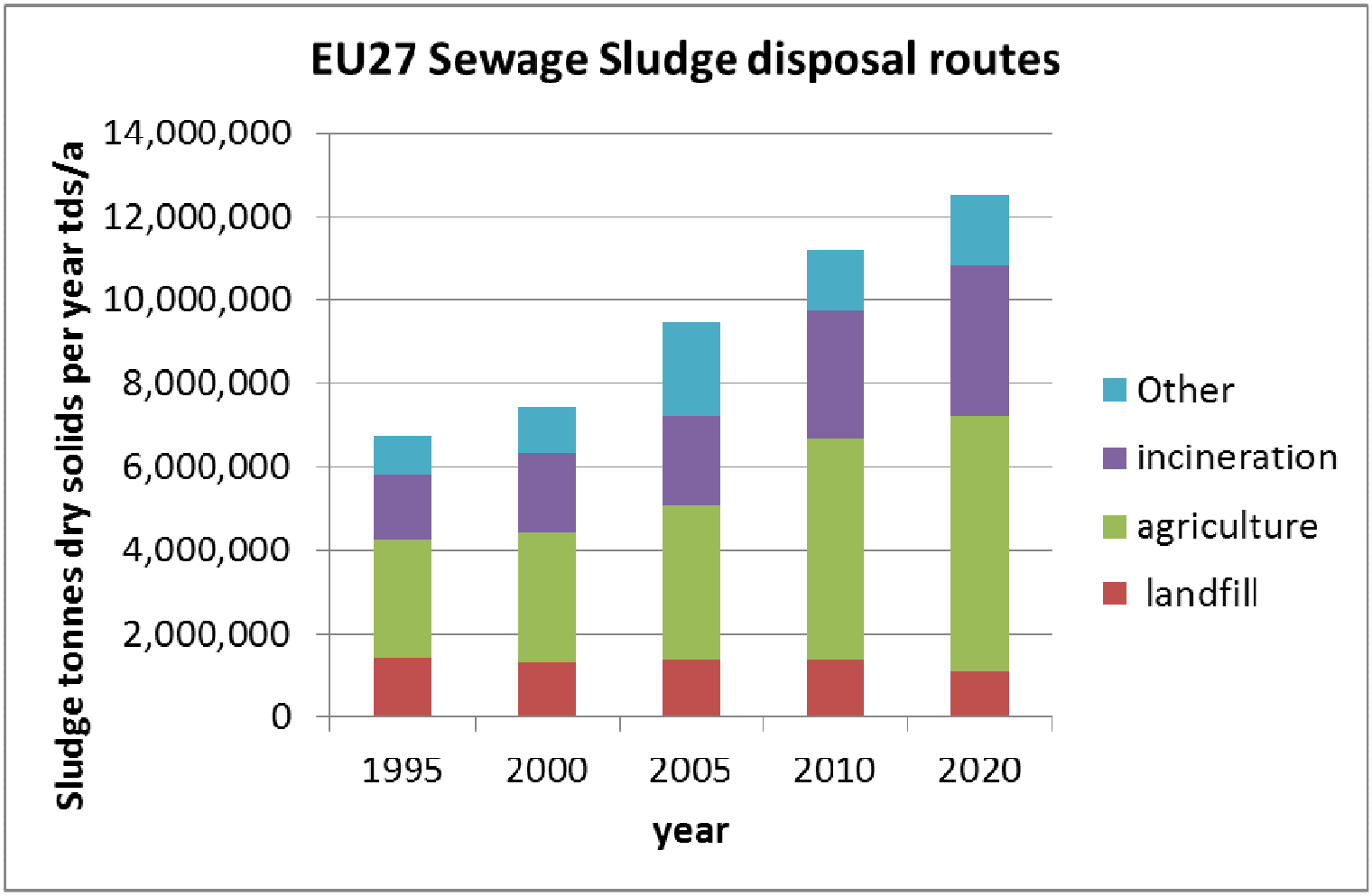


Sludge production rates



Total reported production 2005 / total population

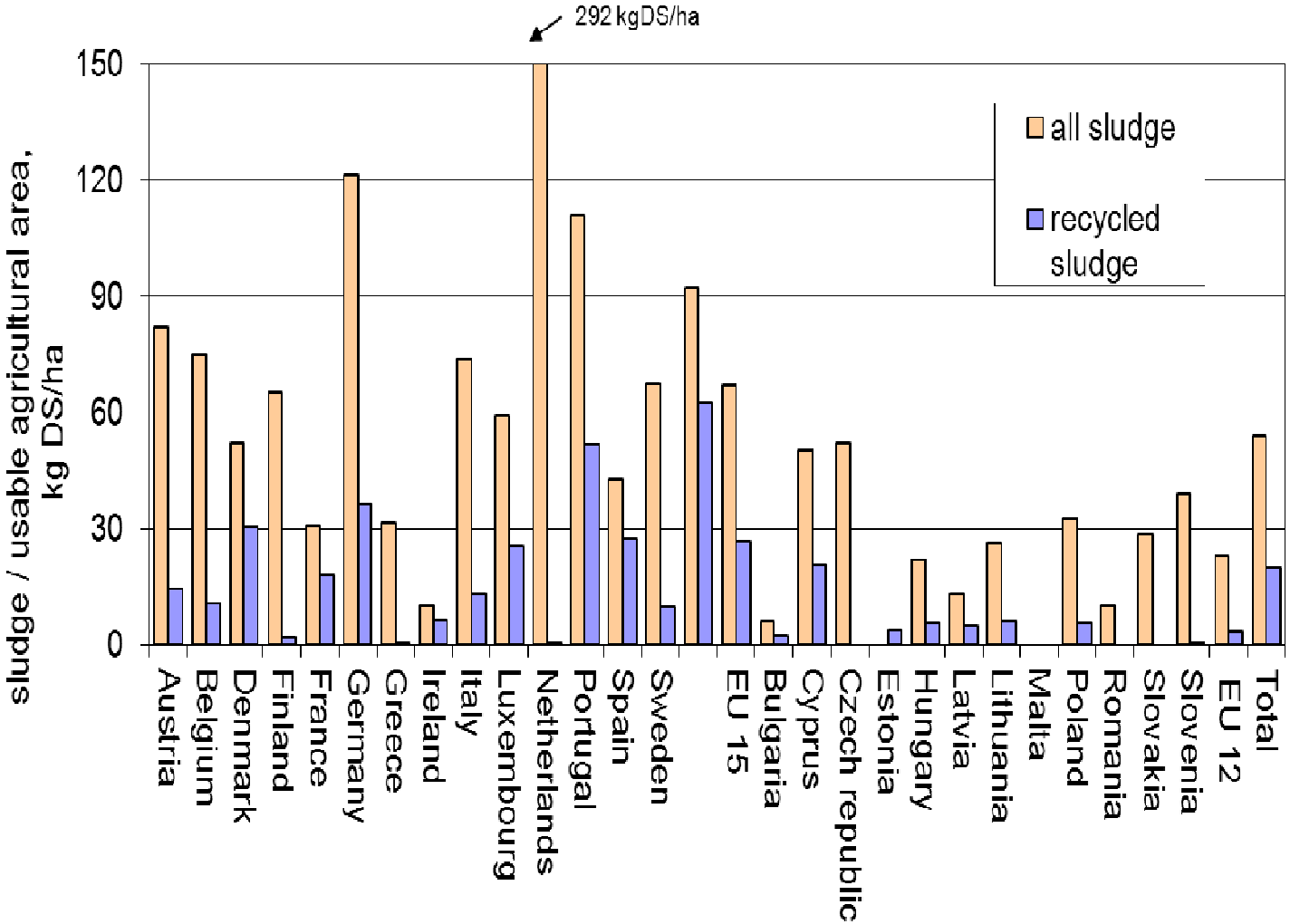
Sludge outlets – all routes to 2020



Agricultural value

- Nitrogen availability of 15%-85%
  - Depends on treatment, availability of ammonia
  - Maximum N loading of 250kg/ha/year, less in nitrate vulnerable zones
  - Sludge required to meet crop N requirement may be greater than P requirement
- Phosphorus availability of 50%
  - May be limited by soil P index
  - Long term P release is not well established
- Sustainable source of Phosphorus

Agricultural recycling rates



Impacts of recycling sludge to land

Emissions	Impacts
Pollutant volatilisation to air	• Human health impacts • Ecosystem degradation
Emissions of pollutants to surface water	• Human health • Decrease in catchment quality
Emissions of pollutants to soil	• Human health impacts • Livestock health • Ecosystem degradation • Soil micro-organisms reduction • Decrease in groundwater quality • Decrease in soil value
Odour	• Social acceptance • Amenity impacts • Public anxiety
Transportation	• Exhaust emissions due to transportation

Reductions in metals content of sludges

Potentially toxic elements (PTEs) concentrations, mg/kg ds						
PTE	UK soil, median	UK sludge 1982/3	UK sludge 2006	UK % reduction	EU sludge 2006	EU sludge range
Cd	0.6	9	1.3	85	1.9	0.4-6.9
Cu	26	625	295	53	207	72-356
Ni	34	59	30	49	27	11-66
Zn	60	1205	574	52	715	332-1235
Pb	29	418	112	73	52	8.9-114
Hg	0.1	3	1.2	60	1.5	0.2-4.6
Cr	84	124	61	51	50	14-127

Greenhouse gas emissions by Sludge processes

Treatment / Disposal Option	Contributions from different operational sources (all expressed as $kgCO_2eq/tRawDS$)							
	Gas use	Electrical energy	Consumables	Transport	CH_4 from process & agriculture	N_2O from process & agriculture	Fertiliser displacement	**Total**
Thermal hydrolysis, anaerobic digestion, dewater, agriculture	0	-222	97	7	124	84	-114	**-25**
Two stage anaerobic digestion, dewater, agriculture	0	-177	100	9	118	90	-123	**16**
Thermal destruction of raw sludge	0	-156	84	1	0	308	0	**236**
Digestion, thermal destruction	0	-165	108	1	100	318	0	**363**
Anaerobic digestion, dry, agriculture	357	-206	106	3	465	101	-137	**689**

Sludge processing and recycling costs

	Sludge process and recycling costs, €/tonne dry solids					
Type of Costs	**Landspreading**			**Landfill**	**Incineration**	
	Digested	**Dewatered**	**Compost**		**Mixed**	**Mono**
Internal costs	193	248	365	300	290	374
Internal benefits (savings in fertiliser)	-63	-63	-92	0	0	0
Net internal costs	**129**	**185**	**273**	**300**	**290**	**374**
Quantifiable external costs (EU15 average)	11	7	13	9	41	37
Quantifiable external benefits (use of fertiliser)	-6	-7	-6	0	0	0
Net external costs	5	0	7	9	41	37
Net costs (€/tds)	**134**	**185**	**280**	**309**	**332**	**411**

Estimated total for 11.8m tds/year = €2950million per year

Directive revision options

- Main areas:
  - Changes to metals in sludge or in soil
  - Introduction of organic substance standards
  - Introduction of pathogen concentration standards
- Subsidiary:
  - Provision of information on nutrient content of sludge
  - Demonstration of stabilised status of sludge
  - Introduction of process monitoring schemes
  - Changes to crop application conditions
  - Changes to quality monitoring and sampling schemes

Sludge Metals - concentrations in options

Sludge metal concentrations				
	Option 1 (current)	Option 2	Option 3	MS average values > Option 3
	mg/kg	mg/kg	mg/kg	
Cd	20-40	10	5	1
Cr	-	1000	150	0
Cu	1000-1750	1000	400	0
Hg	16-25	10	5	0
Ni	300-400	300	50	1 – 2
Pb	750-1200	750	250	0
Zn	2500-4000	2500	600	9
	No value set for Chromium	From CEC 2003 – draft directive revision	Most MS have limit concentrations > (2 x option 3) concentrations	

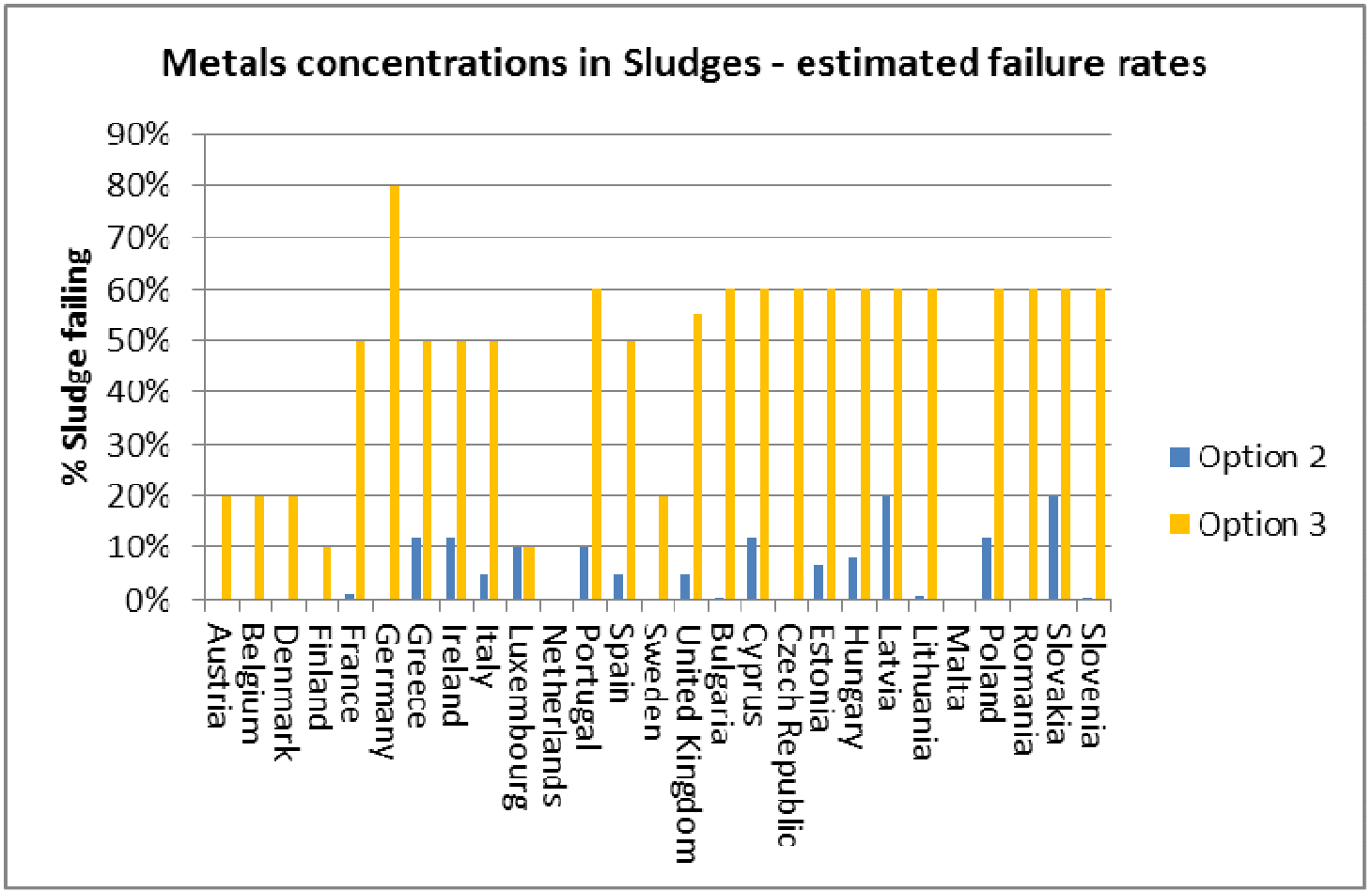
Sludge organic compounds

Sludge organics concentrations				
	Option 2	Option 3	UK means[2]	NRW proposed limits[1]
	mg/kg	mg/kg	mg/kg	mg/kg
Poly aromatic hydrocarbons, PAH	6	6		< 0.4
Poly chlorinated biphenyls, PCB	0.8	0.8	0.22	< 0.05
Polychlorinated dibenzodioxins/furanes, PCDD/F		100 ng ITEQ/kg	36.5	2 – 10 ng ITEQ/kg
Linear alkyl benzone sulphonates, LAS		5000	5560	1100 - 1200
Nonylphenol + NPethoxylates, NPE		450	351	5 - 10

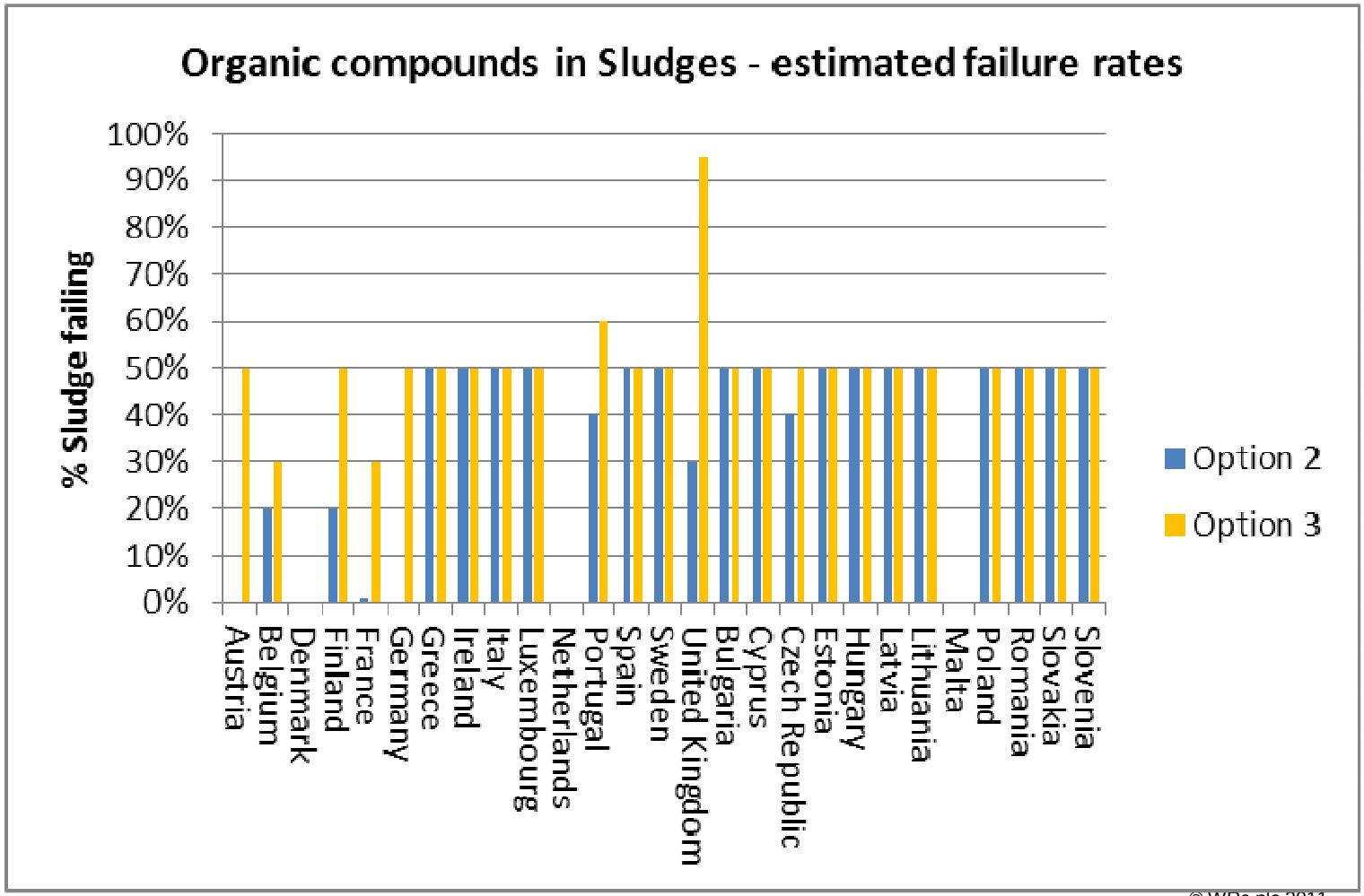
Pathogens in sludge

Option 2	Option 3
Treated sludge	Advanced treated sludge
• ***E.coli*** - < 5 x 10^5 cfu/g wet sludge	• ***E.coli*** - 99.99% reduction and < 10^3 cfu / g ds. • ***Salmonella*** – zero in 50g wet wt sludge. • ***Clostridium perfringens*** - < 3 x 10^3 spores / g ds • checks using ***Ascaris*** and ***Salmonella***
Achieve with traditional treatments	Achieve with advanced treatments

Estimated failure rates for Sludge metals options



Estimated failure rates for Sludge organic compound options



Individual component costs for changes to requirements

	Estimated annualised net costs (EAC), €	
	Option 2 – limited changes	Option 3 – large changes
Sludge PTE concentrations	31,755,000	441,046,000
Organic components	219,730,000	460,398,000
Pathogens in sludge	77,250,000	309,881,000
Quality assurance	2,884,000	4,943,000
Soil PTE concentrations	189,255,000	411,629,000

Total costs of options, high and low scenarios

	Total net cost, € millions		Annualised net cost, € millions	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Option 2 – limited changes	2,174	8	219	0.8
Option 3 – large changes	4,541	48	460	4.9
Option 4 - ban	7,964	7,964	801	801
Note: Present value, PV, discounted at 4% for the period 2010 - 2020				

Estimated current total for 11.8m tds/year = €2950million per year

Conclusions

- Sewage sludge use on agricultural land is widely and safely used in the EU
- There are clear environmental benefits to which values can be assigned
- There are also some costs
- New soil metals standards would be unduly restrictive
- No clear argument for setting new organic compound standards
- No evidence that a complete ban can be justified
- There is support for retention of the Directive – no repeal

Thank-you for your attention

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