Assessing Sediment Chemical Status in Europe: Frameworks, Standards and Approaches, Now and Into the Future

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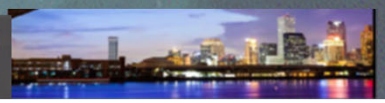
BATTELLE Tenth International Conference on the Remediation and Management of Contaminated Sediments



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The question: How do I screen whether I have an *in situ* "sediment problem"?

- In a range of European countries
  - Canada also examined, but not addressed here
- Marine and freshwater sediments
- Is there guidance?
- Is there a decision framework?
- Are there sediment quality guidelines?
  - For which chemicals?
- Are there chemicals which should be monitored, but are not?

This question was addressed by SedNet over a decade ago

- Evolving issue
  - Reviews getting stale
- Back in 2005, there was a push for Europe-wide sediment guidance
- Most WFD-relevant EQSs are for water, but…
- Article 3 of Directive 2008/105/EC
  - Member States should have the possibility to establish EQS…for sediment and/or biota at national level and apply those EQS instead of the EQS for water set out in the Directive
  - Member States shall arrange for the long-term trend analysis of …those priority substances…that tend to accumulate in sediment and/or biota
  - Monitoring of sediment and biota can…be used to describe the general contaminant status, and supply reference values for local and regional monitoring

Approach

- Select target countries
  - Initially Belgium, France, Germany, Italy, The Netherlands, Norway, UK
- Internet-based document search
- Contact “national experts”
- Review documents (and identify new ones)
- Summarize
- Seek “national expert” review
- Update as necessary
  - Living document

Belgium - Flanders

- The Decree on Soil Remediation and Soil Protection (2006) includes legislation related to the assessment and remediation of sediment
- Criteria for assessing and prioritizing contaminated sediments relies on three levels:
  - criteria related to impact on ecological status,
  - criteria that can describe the aquatic ecosystem, and
  - criteria related to the enhancement of ecology post-remediation. (EI 2013).
- However, a review of documents finds no specific mention of sediments.
  - Sediments are regulated in terms of soil criteria (VLAREBO 2008).
  - Dredged material disposal is addressed in a separate document (VLAREBO 2015).
- Soil guide (little or no risk), target (background), and land remediation (increased risk) values are based on land use.
  - I) natural or protected areas;
  - II) agricultural use;
  - III) residential use;
  - IV) recreational use; and
  - V) industrial use.
- Dredged material disposal is regulated based upon the ultimate use of the site, using these standards

Belgium - Wallonia

- No specific sediment management legislation for Wallonia exists at this time (EI 2013).
- The December 5, 2008 Decree (Wallonia 2008) sets forth the management of contaminated soils and waters
  - Wallonia has three different soil quality levels: reference, intervention, and threshold values

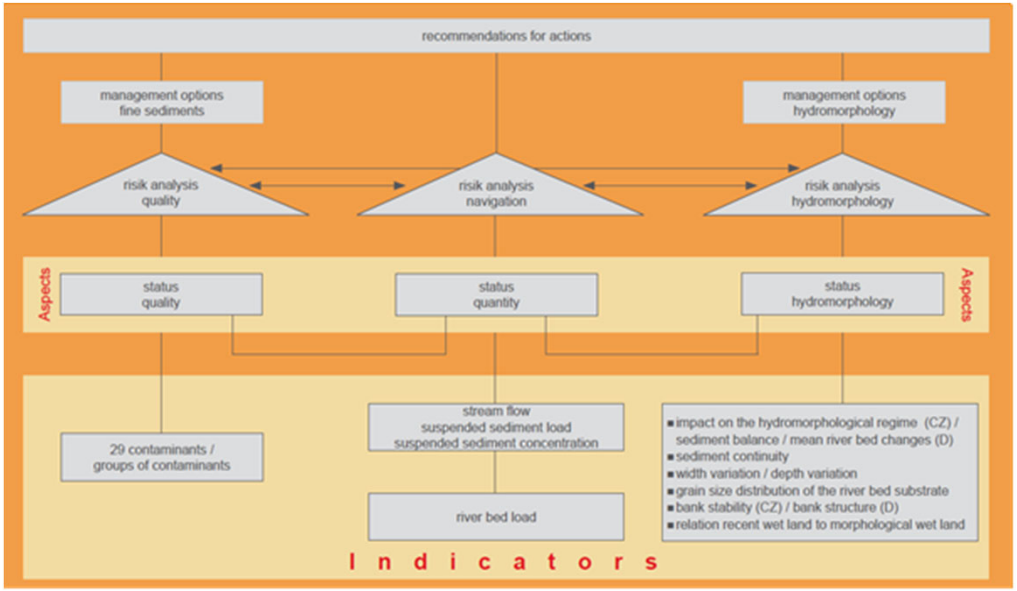
France

- There is no specific legislation for the management of potentially contaminated sediments in France
- Sediment management is triggered indirectly by poor water quality that may be impacted by contaminated sediments
- National sediment quality values for freshwater and marine dredged material disposal
  - Tiered assessment if contaminant levels exceed SQGs

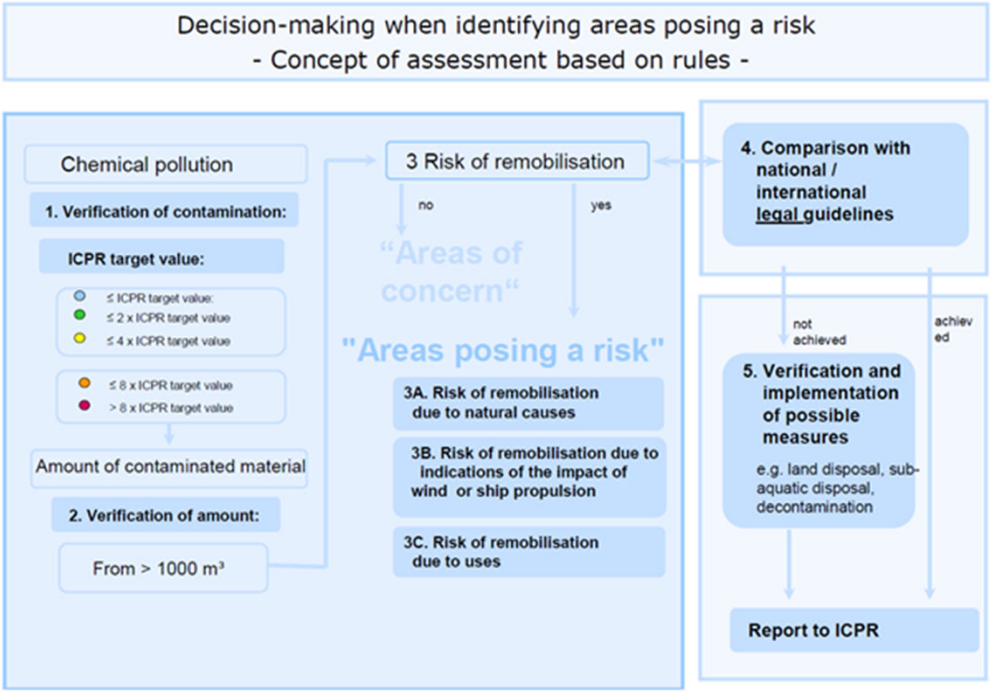
Germany

- German Water Protection Act seeks to achieve good ecological and chemical status, establish monitoring length requirements, and detail exceptions
- The Surface Waters Ordinance establishes limited target concentrations for sediment and suspended material
  - These targets are used to ensure that concentrations in discharges to waterways are minimized
  - Also allows for river-area-specific environmental quality standards
- States developed requirements for sediment and suspended matter investigations based on Federal guidance.
  - For the assessment of water bodies, determination of long-term trends, and the creation of an inventory of contaminated sites.
  - These requirements are not statutory
  - Elbe- and Rhine-specific frameworks and SQGs developed – examples for other regions

Germany: region-specific frameworks



Sediment management framework for the Elbe Catchment (ICPER 2015)



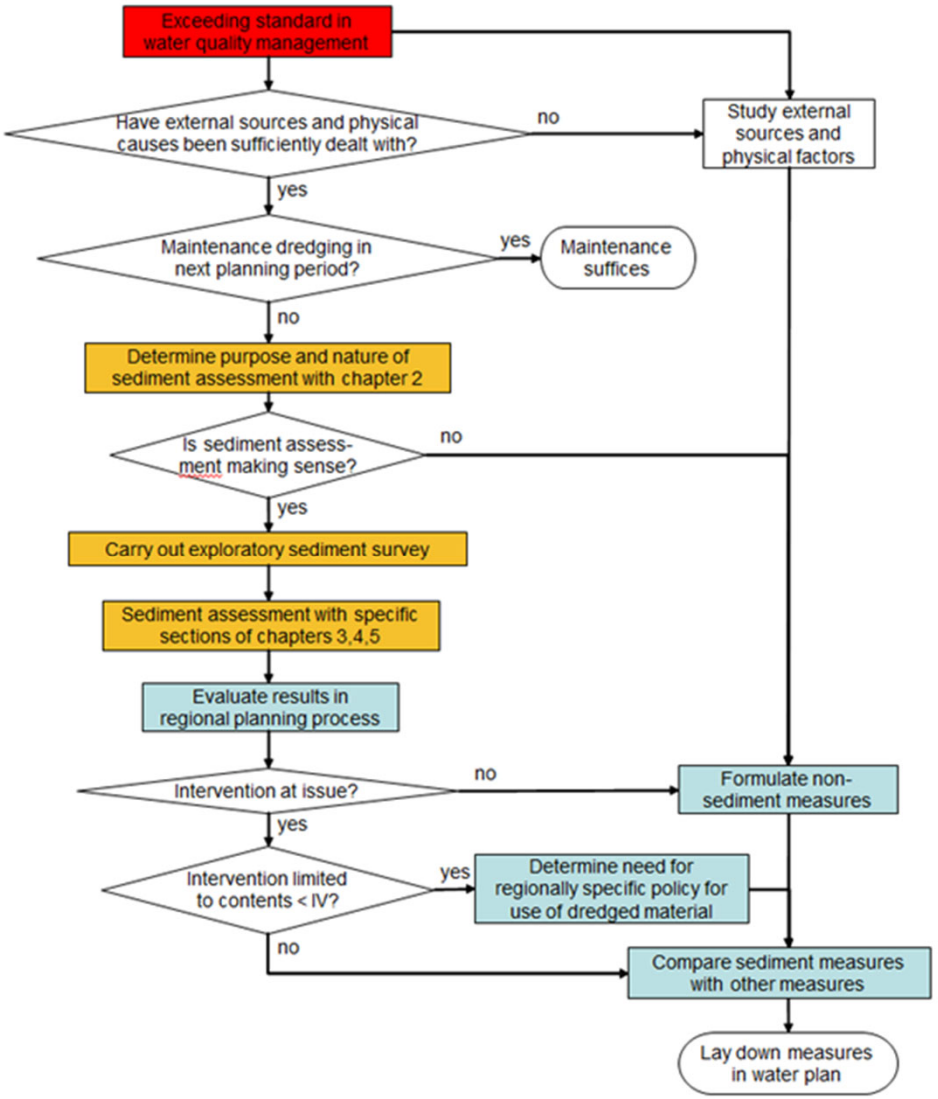
Sediment management framework for the Rhine catchment (ICPR 2009).

Italy

- No sediment-specific decision frameworks, but laws recommend a tiered approach
- In Italy EQS for sediment for marine coastal and transitional waters (the final sink of many pollutants) are a priority
  - However, procedures used for existing EQS are not clear; fixed by old Italian laws (e.g., metal EQS are comparable to background values)
- A national programme for the remediation of contaminated sites has been put in place; some remediation sites of national interest are in marine coastal waters.
  - Most of these sites are high sediment contamination, often with persistent, bioaccumulative and toxic (PBT) substances
  - For those sites, EQS exceedances do not automatically imply remediation – ISPRA is generally charged with defining intervention values
- The Italian Ministry of the Environment has proposed marine SQSs in response to the WFD (by 2021 priority hazardous substances in lagoon waters must be near natural background or very low for naturally occurring or anthropogenic sources)
  - ISPRA provided recommendations for further SQSs. These are not legal standards, but address a few contaminants not addressed in DM
- ISPRA has also developed recommended freshwater sediment reference chemical levels and SQSs

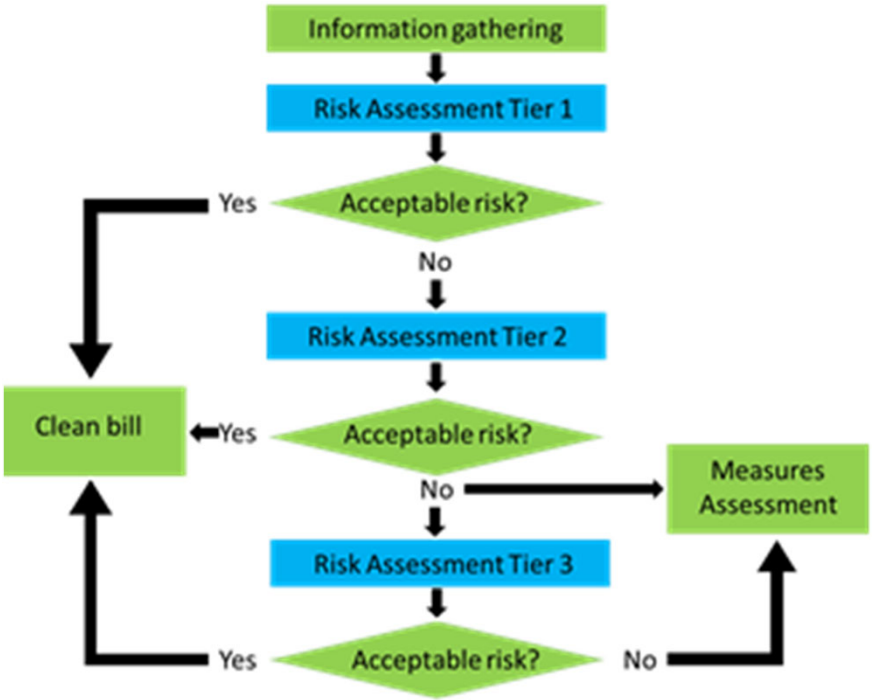
The Netherlands

- Before December 2009, the Dutch Soil Protections Act included protocols for the remediation of sediments
- Sediment quality is now regulated as an integral part of the water system; it is no longer a singular objective
- Water quality management flowchart is followed if there is an exceedance of a water quality standard
  - An exploratory sediment survey determines whether sediment is contributing to the non-compliance
  - If so, concentrations of substances, and the contribution of sediment to water quality is calculated
  - Remediation is only required if effective method to achieve goals of the Water Act or WFD objectives.
- Past target and intervention values, used for soils, sediments and dredged material can still be used to indicate whether sediments may pose risks



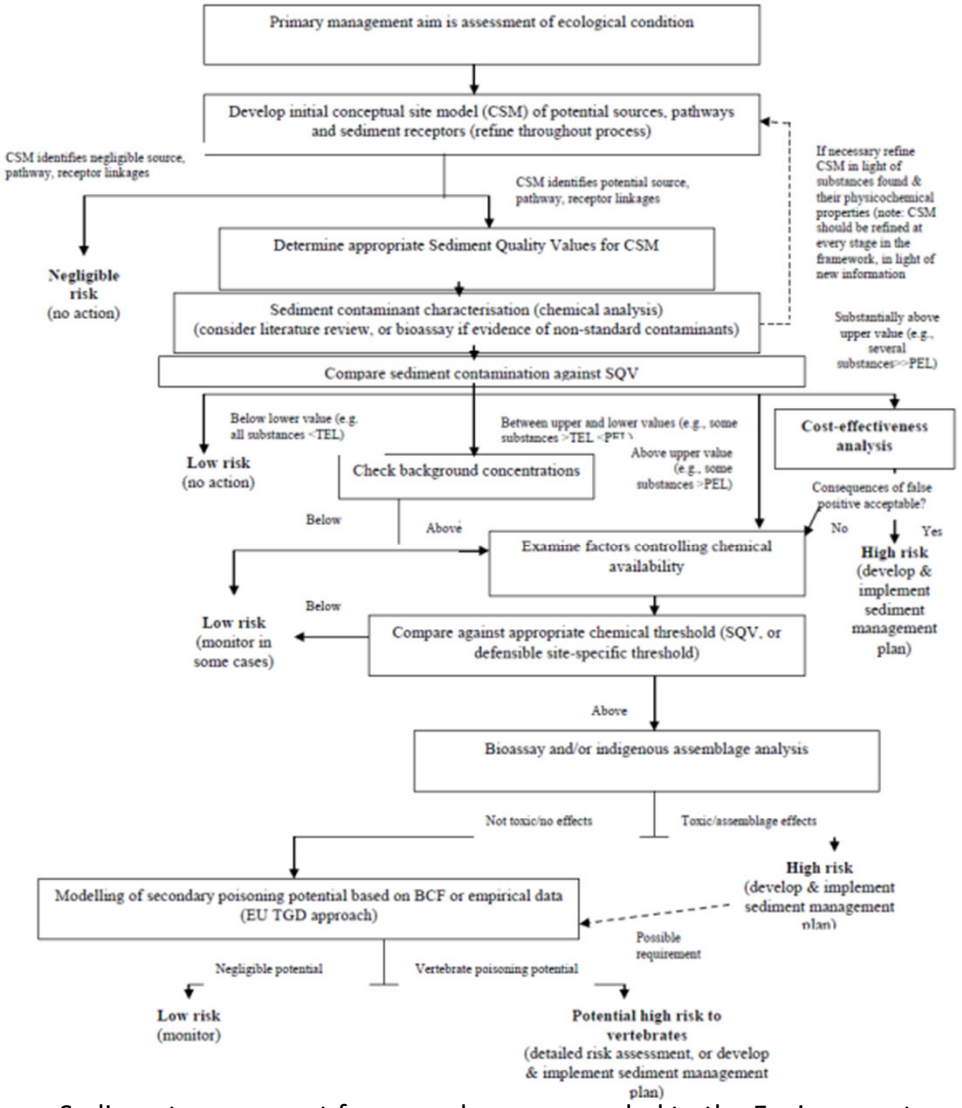
Norway

- Sediment is relevant to the chemical status of water bodies and organisms as a source of pollutants
  - Sediment management can play a part in fulfilling these environmental objectives
- A tiered framework is available
  - Detailed guidance for marine and freshwater sediments
- Marine sediment limit values are available
  - Below these, risk is unlikely
- Marine (and some freshwater) values available for the classification of sediment quality
  - Five classes
- Past target and intervention values, used for soils, sediments and dredged material can still be used to indicate whether sediments may pose risks



United Kingdom

- No sediment-specific guidance or policy
- Tiered framework for SQV use recommended in Environment Agency study in 2005
  - No official frameworks adopted
- The UK has not yet set mandatory standards in sediments
  - International (OSPAR, CCME and ERL) SQGs used for regional and national comparisons
  - National action Levels for Dredged Material for Disposal are available



Sediment assessment framework recommended to the Environment Agency (Apitz et al. 2005).

Country	Regulatory Context	Framework	Sediment Quality Values	Methods Guidance
Belgium (freshwater and marine)	No freshwater or marine in situ sediment specific guidance or policy found	No sediment-specific framework found	Sediment regulated using soil quality values. Flanders has soil guide, target, and use-specific remediation standards; Wallonia has soil reference and use-specific soil threshold and intervention values; North Sea dredged material action levels found	No sediment specific guidance or policy found
France (freshwater and marine)	No specific legislation for the management of potentially contaminated sediments in France; some policy for sediments in terms of waste and dredged material management	No framework for in situ assessment	In the context of waste and dredged material management, two marine and one freshwater SQV identified	No guidance found
Germany (freshwater and marine)	German water protection policy is set forth in the Water Protection Act (Wasserhaushaltsgesetz, WHG) and is based on the management concepts of the EU Water Framework Directive (WFD)	No framework specified; regional frameworks used in some cases	Freshwater and transitional/coastal SQVs available for limited substances in the context of WFD goals; lower threshold and upper threshold values developed for the Elbe; Target values developed for the Rhine	Regional frameworks used as examples in other case studies
Italy (freshwater and marine)	Marine sediment is regulated in the context of WFD and site prioritisation; less focus thus far on freshwater sites	No sediment-specific framework found; tiered generic risk assessment framework identified	National environmental quality objectives and standards available for marine sediments; some freshwater values are proposed by national laboratory groups	Marine guidance found; no freshwater methods were identified
The Netherlands (freshwater and marine)	sediment quality regulated in the context of its impact on water quality; sediment quality is no longer a singular objective	Detailed framework identified for both freshwater and marine systems	Guidance lays out how sediment's role in impacting water quality; non-statutory soil target and intervention values are available	Detailed methods and guidance identified
Norway (marine and freshwater)	Sediment is relevant to the chemical status of water bodies and organisms as a source of pollutants. Sediment management can play a part in fulfilling these environmental objectives	Tiered framework identified	Marine sediment limit values are available; marine (and some freshwater) values available for the classification of sediment quality	Detailed guidance for marine and freshwater systems identified
UK (freshwater and marine)	No sediment specific guidance or policy found	No framework identified; framework for SQV use has been recommended	The UK has not yet set mandatory standards in sediments; OSPAR, CCME, ERL and dredging values are available	No guidance found

What contaminants have standards? Metals

	Netherlands	UK	Norway			Italy		Germany			France	Belgium	
Substance Name	Soil/ sediment target and intervention values	Action Levels for Dredged Material for Disposal	Tier 1 marine sediment limit values	Marine (and freshwater) sediment limit values	Freshwater sediment limit values	Marine sediment values	Proposed national freshwater sediment values	Sediment UQN; OGewV	Lower and upper threshold sediment values; IKSE	Sediment target values; IKSR	SQVs for freshwater and marine dredged material disposal.	Soil guide, target and remediation values (Flanders)	Soil reference, threshold and intervention values (Wallonia)
Antimony	+						+						
Arsenic	+		+	+	+	+	+	+	+		+	+	+
Barium	+												
Beryllium	+						+						
Cadmium	+	+	+	+	+	+	+		+	+	+	+	+
Chromium	**Total Cr**		**Cr III (or total)**	**Cr III (or total)**		**Total Cr; Cr VI**	+	+	+		**Cr III (or total)**	**Cr III**	**Cr III; Cr VI**
Cobalt	+						+						
Copper	+		+	+	+		+	+	+	+	+	+	+
Lead	+	+	+	+	+	+	+		+	+	+	+	+
Mercury	+	+	+	+	+	+	+		+	+	+	+	+
Molybdenum	+												
Nickel	+		+	+	+	+	+		+	+	+	+	+
Selenium	+												
Thallium	+						+						
Tin	+						+						
organotin compounds	**organotin compounds (sum); DBT**		**TBT; triphenyltin**	**TBT; triphenyltin**		**TBT**		**triphenyltin**	**TBT**		**TBT**		
Vanadium	+						+						
Zinc	+		+	+	+		+	+	+	+	+	+	+

What contaminants have standards? Organics

	Netherlands	UK	Norway			Italy		Germany			France	Belgium	
Substance Name	Soil/ sediment target and intervention values	Action Levels for Dredged Material for Disposal	Tier 1 marine sediment limit values	Marine (and freshwater) sediment limit values	Freshwater sediment limit values	Marine sediment values	Proposed national freshwater sediment values	Sediment UQN; OGewV	Lower and upper threshold sediment values; IKSE	Sediment target values; IKSR	SQVs for freshwater and marine dredged material disposal.	Soil guide, target and remediation values (Flanders)	Soil reference, threshold and intervention values (Wallonia)
Benzene	+											+	+
Cresols (sum)	+												
Ethylbenzene	+											+	+
Heptane												+	
hexane												+	
Hydrocarbons													+
Mineral oil	+											+	
Octane												+	
cyclohexanone	+												
Phenol	+												+
PAHs	**total of anthr, BaA, BkF, BAP, chrys, phen, fluoroan, I123cdP, naph and BghiP**	**CEMP9 +naph +DBT; parent +alkylated**	**Σ16**	**acen; acenapt; Anthr; BaA; BaP; BbF; BghiP; BkA; Chry; Fluor; Fluoran; naph; I123cdP; Phen; Pyr**		**sum; Anthr; BaP, BbF; BghiP; benzo(k); Fluor; Napth; I123cdP**	**anthr; BaA; BAP; dibenzo(a); chrys; fluor; fluoranth; napth; pyr**		**BaP, BbF, BghiP, I123cdP; Anthr; BaP; Fluor**	**BaP**	**Σ16; 16 individual**	**16 individual**	**16 individual**
Styrene	+											+	+
Toluene	+											+	+
Xylene	+											+	+

What contaminants have standards? Chlorinated Organics

	Netherlands	UK	Norway			Italy		Germany			France	Belgium	
Substance Name	Soil/ sediment target and intervention values	Action Levels for Dredged Material for Disposal	Tier 1 marine sediment limit values	Marine (and freshwater) sediment limit values	Freshwater sediment limit values	Marine sediment values	Proposed national freshwater sediment values	Sediment UQN; OGewV	Lower and upper threshold sediment values; IKSE	Sediment target values; IKSR	SQVs for freshwater and marine dredged material disposal.	Soil guide, target and remediation values (Flanders)	Soil reference, threshold and intervention values (Wallonia)
Chloromethanes	**di-; tri-; tetra**		**tri-;**								**tri-**	**di-; tri-; tetra**	**di-; tri-; tetra**
1,1-Dichloroethane	**1,1-; 1,2-**										**1,2-**	**1,1-; 1,2-**	**1,2-**
1,2-Dichloropropane	**+**												
C10-13 Chloroalkanes			**+**	**+**									
Trichloroethane	**1,1,1-; 1,1,2-**											**1,1,1-; 1,1,2-**	**1,1,1-**
Tetrachloroethane	**+**												
vinyl chloride (chloroethene)	**+**											**+**	**+**
1,1-dichloroethene	**1,1-; 1,2-**											**1,1-**	**1,2-**
Trichloroethylene	**+**											**+**	**+**
Tetrachloroethylene (PCE)	**+**											**+**	**+**
chlorobenzenes (sum)	**sum**		**tri-; penta-; hexa-**	**tri-; penta-; hexa-**		**hexa-**	**penta-; hexa-**		**penta-; hexa-**			**mono-; 1,2-di-; tri-; 1,2,4,5-tetra-; penta-; hexa-**	
chloronaphthalene (sum)	**+**												
Dioxins and dioxin-like compounds			**+**	**+**		**+**			**dioxins/ furans**				
chlorophenols	**sum**											**2-chloro; 2,4-di; 2,4,5-; 2,4,6-tri; 2,3,4,6-tetra-; sum**	
PCBs	**Σ7**	**Σ7**	**Σ7**	**+**		**ΣPCB28, 52, 77, 81, 101, 118, 126, 128, 138, 153, 156, 169, 180**	**+**	**PCB28; 52; 101; 138; 153; 180**	**PCB28; 52; 101; 138; 153; 180**	**Σ7; 153**	**Σ7; individuals**	**Σ7**	

What contaminants have standards? Biocides

	Netherlands	UK	Norway			Italy		Germany			France	Belgium	
Substance Name	Soil/ sediment target and intervention values	Action Levels for Dredged Material for Disposal	Tier 1 marine sediment limit values	Marine (and freshwater) sediment limit values	Freshwater sediment limit values	Marine sediment values	Proposed national freshwater sediment values	Sediment UQN; OGewV	Lower and upper threshold sediment values; IKSE	Sediment target values; IKSR	SQVs for freshwater and marine dredged material disposal.	Soil guide, target and remediation values (Flanders)	Soil reference, threshold and intervention values (Wallonia)
Alachlor			+	+									
Atrazine	+												
carbaryl	+												
carbofuran	+												
Chlordane	+												
Chlorfenvinphos			+	+									
Chlorpyrifos	+		+	+									
Cyclodiene pesticides	**aldrin; dieldrin; endrin**					+	+						
DDT total	**total**		+	**total; para-para;**		**total**	**DDT; DDD; DDE**		**DDT; DDD; DDE**				
DEHP			+	+									
Diflubenzuron			+	+									
Diuron			+	+									
Endosulfan	+		+	+									
Heptachlor and heptachlor epoxide	+												
Hexachlorobutadiene (HCBD)			+	+									
Hexachlorocyclohexane (HCH)	+		**+; lindane**	**+; lindane**		**+; lindane**	**lindane**		+				
Maneb	+												
Pentachlorophenol (PCP)	+		+	+								+	
Simazine													
Teflubenzuron			+	+									
Triclosan			+	+									

What contaminants have standards? other

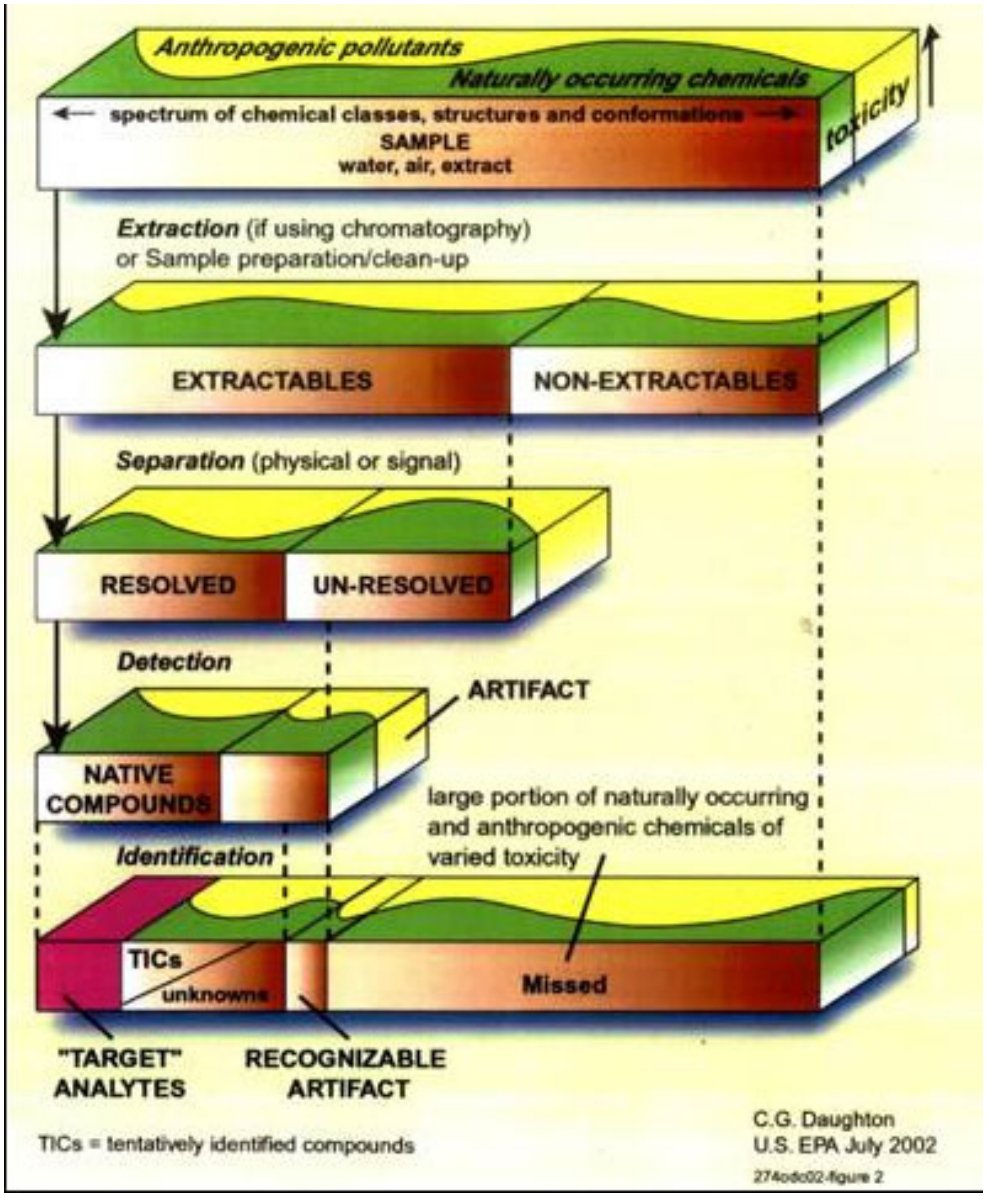
	Netherlands	UK	Norway			Italy		Germany			France	Belgium	
Substance Name	Soil/ sediment target and intervention values	Action Levels for Dredged Material for Disposal	Tier 1 marine sediment limit values	Marine (and freshwater) sediment limit values	Freshwater sediment limit values	Marine sediment values	Proposed national freshwater sediment values	Sediment UQN; OGewV	Lower and upper threshold sediment values; IKSE	Sediment target values; IKSR	SQVs for freshwater and marine dredged material disposal.	Soil guide, target and remediation values (Flanders)	Soil reference, threshold and intervention values (Wallonia)
Asbestos	+												
Bisphenol A (BPA)			+										
Cyanide	+											+	+
Decamethylcyclo-pentasiloxane (D5)			+	+									
Dodecylphenol, med isomer			+	+									
HBCDD			+	+									
MCCP			+										
MCPA	+												
Methyl tertbutylether (MTBE)												+	+
mono-chloroanilins (sum)	+												
Nonylphenol (4-nonylphenol)			+	+									
Octylphenol			+	+									
penta BDE			+	+									
PFOA			+	+									
PFOS			+	+									
phthalates (sum)	+												
PBDE				+									
pyridine	+												
TBBPA			+	+									
tetrahydrofuran	+												
tetrahydrothiophene	+												
thiocyanates (sum)	+												
Trifluralin				+									
TCEP			+	+									

Do longer action lists better predict toxicity?

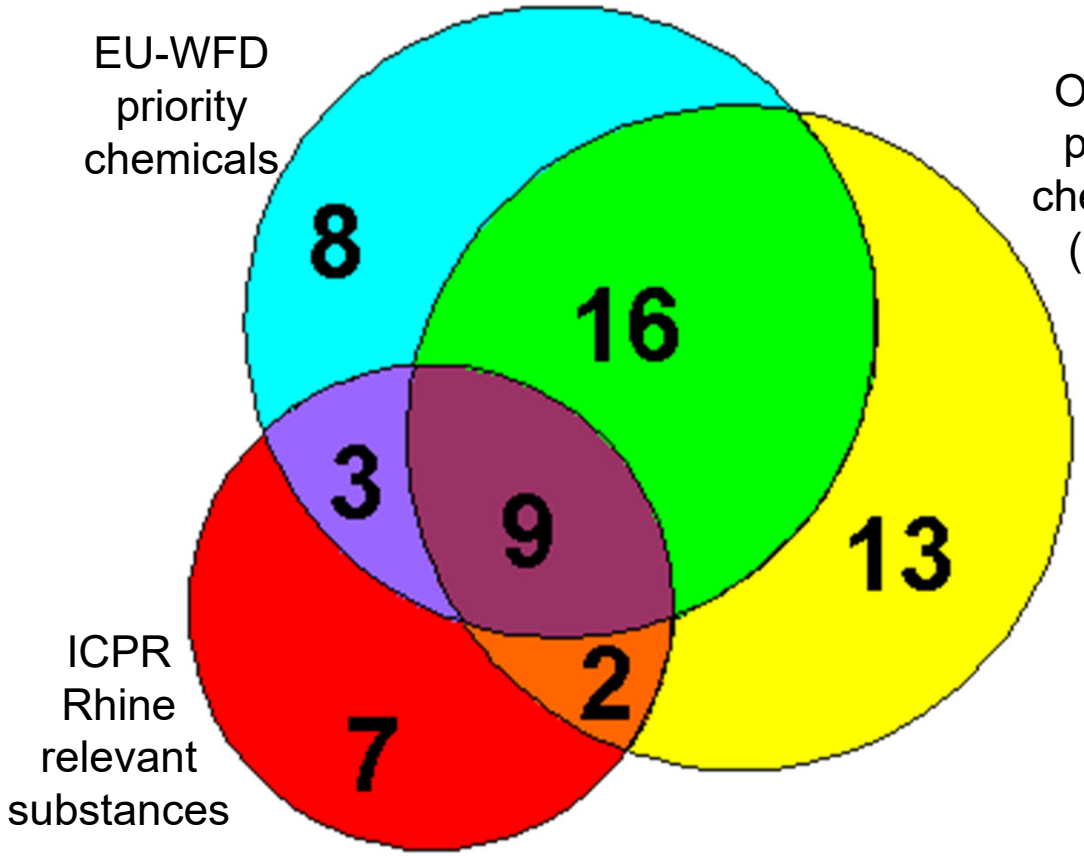
- Increasing chemical action list increases protectiveness
  - Fewer false negatives
  - But, at a cost of false positives
- Short list of "sentinel" compounds does not predict toxicity of other, unmeasured compounds
- **So, what "emerging" contaminants should be considered?**

	Scenario	I↑	II↓	III↓	IV↕?	V↑	VI ↑	% Ocean Disposal	% Special Handling	% No Ocean Disposal
Status Quo	1) Canadian DaS (with DaS SQGs)[1,5]	634 58.7%	148 13.7%	14 1.3%	176 16.3%	68 6.3%	41 3.8%	89.9	6.3	3.8
Performance of "One out / All out" Rule with 'Expanded Chemistry' Scenarios	2) DaS[1,5]	617 57.1%	158 14.6%	12 1.1%	193 17.9%	58 5.4%	43 4.0%	90.7	5.4	4
	3) DaS+metal[2,5]	504 46.6%	107 9.9%	10 0.9%	306 28.3%	109 10.1%	45 4.2%	85.8	10.1	4.2
	4) DaS + organics[3,5]	379 35.1%	88 8.1%	9 0.8%	431 39.9%	128 11.8%	46 4.3%	83.9	11.8	4.3
	5) Full[4,5]	333 30.8%	74 6.9%	7 0.7%	477 44.1%	142 13.1%	48 4.4%	82.4	13.1	4.4
Performance of mHQ cAL1	6) DaS 0.2 cAL1 mHQ[1,6]	448 41.4%	95 8.8%	7 0.7%	362 33.5%	121 11.2%	48 4.4%	84.4	11.2	4.4
	7) DaS + metal 0.2 cAL1 mHQ[2,6]	347 32.1%	49 4.5%	7 0.7%	463 42.8%	167 15.5%	48 4.4%	80.1	15.5	4.4
	8) DaS + organics 0.2 cAL1 mHQ[3,6]	338 31.3%	76 7.0%	5 0.5%	472 43.7%	140 13.0%	50 4.6%	82.4	13	4.6
	9) Full 0.2 cAL1 mHQ[4,6]	295 27.3%	54 5.0%	4 0.4%	515 47.6%	162 15.0%	51 4.7%	80.3	15	4.7

What we can analyze is only a fraction of what is there



Comparison of lists of priority chemicals in different programmes affecting Rhine Sediments



(PORII, Port of Rotterdam)
Slide Courtesy of Jos Brils, TNO

- Many of the toxicants in European Rivers are not Priority Pollutants
- But “not everything that can be measured is worth measuring, and not everything worth measuring is measurable.” (Daughton 2002)

Compound	Priority substance [a]	Confirmed [b]	Site/basin	Reference
Mutagenicity/genotoxicity				
benzo[a]pyrene, benzo(k)fluoranthene, indeno[1,2,3-cd]pyrene, benzo[ghi]perylene	Yes	Yes	Many sites worldwide	e.g. (Brack et al. 2005b)
perylene, benz[a]fluoranthene	No	Yes	Neckar basin (Germany)	Brack et al. 2005b
11H-indeno[2,1,7-cde]pyrene, methyl benz[a]anthracenes and perylenes	No	No	Neckar basin (Germany)	Brack et al. 2005b
polar polycyclic compounds including benz[a]anthracenquinone, pyrenequinone, nitropyrenequinone, nitroanthraquinone, nitrobenzanthracenedione, 6-nitrochrysene, nitrobenzo[a]-pyrenes, nitroindeno[1,2,3-cd]pyrene	No	No	Mediterranean Sea, coastal zone at Barcelona (Spain)	(Fernandez et al. 1992)
Ah-receptor-mediated effects				
PCDD/Fs, PCBs	No	Yes	Western Scheldt (The Netherlands), Spittelwasser (Elbe basin, Germany)	(Stronkhorst et al. 2002, Klamer et al. 2005, Brack et al. 2002)
benzo[a]pyrene, benzo(k)fluoranthene, indeno[1,2,3-cd]pyrene, benzo[ghi]perylene	Yes	Yes	Morava river (Danube basin, Czech Republic)	(Vondracek et al. 2004, Hilscherova et al. 2001, Machala et al. 2001c)
dinaphthofurans, 2-(2-naphthalenyl)benzothiophene, 9-methylbenz[a]anthracene, 1-methylchrysene	No	Yes	Spittelwasser (Elbe basin, Germany)	(Brack and Schirmer 2003)
Estrogenicity				
nonylphenol	Yes	Yes	Llobregat (Spain), river Neckar	(Céspedes et al. 2005, Hollert et al. 2005)
benzophenone, phthalates, dehydroabietic acid, sitosterol, 3-(4-methylbenzylidine)camphor, 6-acetyl-1,1,2,4,4,7-hexa-methyltetralin	No	No	Rivers Neckar, Rhine (Germany), Thames (United Kingdom)	(Fiastall et al. 2006)
tributyltin	Yes	Yes	Elbe (Germany)	(Brack et al. 1999, Schulte-Oehlmann et al. 2001)
17β-estradiol, estrone, estriol	No	Yes	United Kingdom estuaries, different rivers in the Netherlands, Swiss wastewater treatment plant effluents	(Thomas et al. 2001, Houtman et al. 2004, Aerni et al. 2004)
Androgenicity				
dehydrotestosterone, androstenedione, androstanedione, 5β-androstane-3α,11β-diol-17-one, androsterone, epi-androsterone	No	Yes	United Kingdom estuaries	(Thomas et al. 2002b)
Green algae				
N-phenyl-2-naphthylamine, prometryn	No	Yes	Spittelwasser (Elbe basin, Germany)	(Brack et al. 1999)
priority PAHs, tributyltin	Yes	Yes	Spittelwasser (Elbe basin, Germany)	(Brack et al. 1999)
Invertebrates				
methyl parathion	No	Yes	Spittelwasser (Elbe basin, Germany)	(Brack et al. 1999)
pentachlorophenol, atrazine	Yes	No	United Kingdom estuaries	(Thomas et al. 1999)
tri-, tetra-chlorphenol, 4-chloro-3,5-dimethylphenol, nonylphenol, 4-chloro-3,5-xylenol, dieldrin, carbophenothion methylsulfoxide	No	No	United Kingdom estuaries	(Thomas et al. 1999)

[a] according to EU-WFD
[b] confirmed as a cause of the measured effect

Brack W, Klamer HJC, Alda ML, Barceló D. 2007b. Effect-Directed Analysis of Key Toxicants in European River Basins A Review. Env Sci Pollut Res 14(1):30-38.

Emerging contaminants - PCPPs

Chemical	Use	Sediment persistence	HQ in sediments	Recommended fraction in JRC watch list	Found in European river sediments
Azithromycin	antibiotic		Highest	√	
Ciprofloxacin	antibiotic		Highest	√	
Clarithromycin	antibiotic		Highest	√	
flumequine,	antibiotic		Medium		
oxytetraclycline	antibiotic		Medium		
2-ethylhexyl 4-methoxycinnamate	PCPP, sunscreen		Highest	√	
[14C]diazepam	pharmaceutical	high (lab)			
[14C]iopromide	pharmaceutical	moderate (lab)			
carbamazepine	pharmaceutical	high (lab)			
CBZ-diol	pharmaceutical	high (lab)			
clofibric acid	pharmaceutical	high (lab)			
Erythromycin	pharmaceutical		Highest	√	
ivermectin	pharmaceutical	moderate (lab)			
oxazepam	pharmaceutical	moderate (lab)			
Ethinylestradiol	steroid oestrogens				detected in some
Oestrone	steroid oestrogens	high (lab)			detected at high levels

Emerging contaminants - various

Chemical	Use	Sediment persistence	HQ in sediments	Recommended fraction in JRC watch list	Found in European river sediments	Soil/Sediment QG
PFOS; PFOA	firefighting, waterproofing				present in lake sediments; accumulates in Germany	Norway
BDE-209	flame retardant				Concerning levels in Ebro	
organophosphorus flame retardants (OPFRs)	flame retardant	additive toxicity			frequent detection	
PBDE	flame retardant	persistent	persistent, highly accumulative		found	Norway
BHT	food additive		Highest	√		
Dichlofluanid	fungicide		Highest	√		
Diflufenican	herbicide		Higher risk for water, but sediment exceedances found			
Benzophenone	indistrial				high levels	
PCDD, PCDF	industial/thermal by-product				detected in all UK sediments sampled	Norway, Italy, Germany
Triphenyl phosphate	industrial chemical; PCPP		Highest	√		
Bisphenol-a; BPA	Plasticiser	soils and othe solids modest sinks			found/ high	Norway
DEHP	Plasticiser	accrues in solids; sediments long-term source and sink			found	Norway
Phthalates	Plasticiser	low to medium			found	Netherlands
nonylphenol	surfactant degradation product	medium	endocrine disruption		found	Norway
Benzotriazoles (BTs)	ultraviolet (UV) stabilizers				found	
Alkylphenols, ethoxylates and carboxylates	various				high levels	
microplastics					Accumulating (not Europe-specific)	
Steriod sex hormones		moderate	endocrine disruption		found	

Summary

- Each country examined differed in its approach to sediment assessment
- For most countries, some guideline values could be identified for use
  - However, these differed vastly in action lists and narrative intent
- Longer (but regionally relevant) action lists are more protective than short ones
  - But the chemicals generally monitored are not always the main drivers of toxicity
- There are many lines of evidence for the selection of new analytes
  - The JRC watch list focuses on contaminants with high HQs in sediment
  - Reported incidence in sediments
  - Persistence in sediments or PBT properties
  - Availability of SQVs
- The selection of analytes, standards and approaches should be driven by site conditions, regulatory context and assessment objectives
- Feel free to contact me for more details – **drsea@cvrl.org**