

Assessment Criteria for Dredged Material

with special focus on the North Sea Region

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Table of Content

1	Introduction.....	3
2	Datasheets.....	4
2.1	Germany.....	4
2.2	The Netherlands.....	7
2.3	Belgium	9
2.4	France.....	11
2.5	United Kingdom (England and Wales)	14
2.5.1	Current Legislation	14
2.5.2	UK Revised Action Levels	14
2.6	Ireland	17
2.7	Norway.....	19
2.8	Denmark.....	22
2.9	Spain.....	24
3	Cross national comparison of action levels.....	26
3.1	Arsenic (As)	27
3.2	Lead (Pb)	28
3.3	Cadmium (Cd)	29
3.4	Chromium (Cr)	30
3.6	Nickel (Ni).....	32
3.7	Mercury (Hg).....	33
3.8	Zinc (Zn).....	34
3.9	Polychlorinated Biphenyl (PCB ₇).....	35
3.10	Tributyltin (TBT)	36

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1 Introduction

Different national guidelines are in use for the management of dredged material in the countries of the North Sea region. The framework for these guidelines is given by international conventions, like the London Convention (LC) 1972, and the Oslo-Paris Convention (OSPAR). The implementation and the setting of assessment criteria is within the custody of each country. Hence, there are differences concerning the assessment criteria for the material to be disposed at sea.

The main intention of this paper is to compare the applied criteria for assessing chemical contamination of sediments. In the first part of the document datasheets give a detailed overview about criteria in Germany, The Netherlands, Belgium, France, UK, Ireland, Norway, Denmark, and – in addition – Ireland and Spain. All countries make use of guidance levels and/or threshold levels for the characterisation of dredged material. The respective intent of these “action levels” is indicated within the datasheets. Additional information, for example on the use of bioassays, is given in the description. More explanations for different national values are to be found in the OSPAR documents below.

In the second part of the document a (graphical) comparison between national standards is presented. This is only indicative because different national approaches are used; in addition parameters may not be directly comparable due to different grain size fractions in which analysis has to be conducted.

The “OSPAR Guidelines for the Management of Dredged Material” are the international framework. Download:

[http://www.ospar.org/v_measures/get_page.asp?v0=09-04e_Guidelines on dredged material.doc&v1=5](http://www.ospar.org/v_measures/get_page.asp?v0=09-04e_Guidelines%20on%20dredged%20material.doc&v1=5).

The OSPAR Commission presented an “Overview of Contracting Parties’ National Action Levels for Dredged Material (2008 Update)”. Download:

http://www.ospar.org/documents/dbase/publications/p00363_action%20level%20belgium.pdf

This paper does not describe all other guidance included in the frameworks, for this is referred to the specific documents. References and web links are given.

A technical remark at the beginning: The ratio between TBT and TBT-Sn is 2.44; so if you have a concentration of 100 µg Sn / kg the TBT concentration is 244 µg / kg.

2 Datasheets

2.1 Germany

The international regulations of the London Convention (LC), Oslo-Paris Convention (OSPAR) and Helsinki Convention (HELCOM) were transposed into a German directive for dredged material management in coastal areas under federal administration (WSV-HABAK, 1999).

In August 2009, a new transitional regulation for the handling of dredged material in coastal areas was agreed between the Federal government and the federal coastal states. Subsequently it is now being transposed in the specific areas of responsibility; the HABAK is repealed.

Metal standards are referring to the grain size fraction < 20 µm, organic parameters are referring to the fraction < 63 µm, except TBT which is applied to the total fraction (all referring to dry solids). Metals are measured directly, organic contaminants are deducted from total sample concentrations and the percentage of the fraction < 63µm.

Metals	Substance	Unit	RW ₁	RW ₂	Guidance Level
	Arsenic (As)	mg/kg	40	120	
	Lead (Pb)	mg/kg	90	270	
	Cadmium (Cd)	mg/kg	1,5	4,5	
	Chromium (Cr)	mg/kg	120	360	
	Copper (Cu)	mg/kg	30	90	
	Nickel (Ni)	mg/kg	70	210	
	Mercury (Hg)	mg/kg	0,7	2,1	
	Zinc (Zn)	mg/kg	300	900	

Organic Contaminants	Substance	Unit	RW ₁	RW ₂	Guidance Level
	Summe PCB ₇	µg/kg	13	40	
	α - Hexachlorcyclohexane	µg/kg	0,5	1,5	
	γ - Hexachlorcyclohexane	µg/kg	0,5	1,5	
	Hexachlorbenzene	µg/kg	1,8	5,5	
	Pentachlorbenzene	µg/kg	1	3	
	p,p' - DDT	µg/kg	1	3	
	p,p' - DDE	µg/kg	1	3	
	p,p' - DDD	µg/kg	2	6	
	TBT Wadden Sea*	µg/kg	20	100	
	TBT*	µg/kg	20	300	
	Hydrocarbons	mg/kg	200	600	
	PAH ₁₆	mg/kg	1,8	5,5	

* referring to total fraction

Nutrients			Guidance Level
Total Phosphorus	Sediment	< 500 mg/kg DS	
Total Nitrogen		< 1500 mg/kg DS	
Total Phosphorus	Eluat	< 2 mg/l	
Total Nitrogen		< 6 mg/l	

Derivation of values

The action values are based on existing data about sediment contaminant concentration in the German part of the Wadden Sea and the coastal sediments of the Northern Sea (and Baltic Sea, not specified here). RW_1 is equivalent to the 90th percentile of the current regional contamination.

RW_2 is obtained by multiplying RW_1 with a factor of 3. The only exception is TBT.

Sampling

The size of the dredging area, the volume of dredged material and the horizontal and vertical variation of contaminant intensity at the river bed, have to be included. The number of samples depends on the total volume, generally samples have to be analysed individually, only in specific cases the analysis of a combined sample is possible.

Interpretation

The standards are guidance values.

Case I

Analysis results below RW_1 : The material complies with the background contamination of the coastal area. Beneficial use/direct use is to be considered, placement has to be carried out under consideration of physical and biological effects.

Case II

Analysis results in between RW_1 and RW_2 : This material has a higher degree of contamination compared to the coastal zones (at least one parameter $> RW_1$, no parameter $> RW_2$). Beneficial use/direct use options need to be verified, and a full impact assessment has to be prepared. If necessary, go to Case III. Further monitoring is necessary (fish, benthos). Measures for impact minimization need to be considered.

Case III

Analysis results above RW_2 : This material is significantly higher contaminated compared to sediments in the coastal areas (at least one parameter $> RW_2$). Procedure similar to Case II but additionally the source of contamination needs to be determined and if possible remediated. Safe disposal (landfill) and treatment options have to be considered.

Ecotoxicological analyses

Ecotoxicity	Level of dilution without effects	pT-value of single tests	Classification
	Original	0	0
1 : 2	1	I	
1 : 4	2	II	
1 : 8	3	III	
1 : 16	4	IV	
1 : 32	5	V	
1 : 64	=>6	VI	

Bioassays have to be implemented in Case III. These tests are used to assess the toxicity of the dredged material. Qualified tests are

- marine algae test
- luminous bacteria test
- acute toxicity test with amphipods.

The pT-value is the result of the most sensitive organism within a test series of bioassays on the same level.

Bioassays are used besides other criteria in decision making of a disposal option. Toxicity classes 0 – II are considered to be harmless. Higher results have to be considered in the impact prognosis; in these cases the reasons for elevated toxicity shall be identified.

Source

Gemeinsame Übergangsbestimmungen zum Umgang mit Baggergut in den Küstengewässern, August 2009
http://www.bafg.de/nn_161232/Baggergut/DE/04_Richtlinien/guebag_templateld=raw,property=publicationFile.pdf/guebag.pdf

2.2 The Netherlands

Assessment values for dredged material are regulated by the ZBT - Zoute Bagger Toets (2007), which is a modification of the prior guideline, the CTT. The ZBT does no longer include bioassays, like the CTT did.

The Netherlands is the only country using only one set of action levels. Guidance levels and strict threshold levels are used in combination.

All values given in the table are referring to dry solids and apply to total samples.

	Substance	Unit	Value	
Metals	Arsenic (As)	mg/kg	29	Guidance Level
	Lead (Pb)	mg/kg	110	Threshold Value
	Cadmium (Cd)	mg/kg	4	Threshold Value
	Chromium (Cr)	mg/kg	120	Guidance Level
	Copper (Cu)	mg/kg	60	Guidance Level
	Nickel (Ni)	mg/kg	45	Threshold Value
	Mercury (Hg)	mg/kg	1,2	Threshold Value
	Zinc (Zn)	mg/kg	365	Guidance Level

	Substance	Unit	Value	
Organic Contaminants	Sum PCB ₇	µg/kg	100	Threshold Value
	Hexachlorbenzene	µg/kg	20	Threshold Value
	Sum DDT/DDD/DDE	µg/kg	20	Threshold Value
	TBT	µg Sn/kg	250	Threshold Value
	TBT as in Wvz*	µg Sn/kg	115	Threshold Value
	Mineral Oil	mg/kg	1250	Guidance Level
	PAH ₁₀ **	mg/kg	8	Threshold Value

* Wvz - Wet Verontreiniging Zeewater: Act for the coastal region and the Exclusive Economic Zone (EEZ), the lower threshold value for TBT is used in regard to this region

** Anthracen, Benz-a-anthracen, Benz-ghi-perylen, Benz-a-pyren, Chrysen, Flouranthen, Indeno-1,2,3-cd-pyren, Phenanthren, Naphthalene, Benzo-k-flouranthene

Deduction of values

All values used in the ZBT document are derived from background concentrations. Adjustments have been made in 1994, 1998 and 2006 (OSPAR, 2008).

Sampling

Port areas in the Netherlands are divided into designated zones, a complete map is available at the website of Rijkswaterstaat Water Service (Havenvakkennummers). Before dredging a number of 6 samples is taken from each zone and further mixed and combined to one representative sample. On basis of the contaminant content of this sample further actions are taken.

Interpretation

Threshold values are given for priority substances which are mostly organic contaminants but also selected metals. These values are treated as strict limit values without exceptions. For non-priority substances an exceedance of up to 50% is tolerable as long as it only concerns 2 substances.

Sources

Rijkswaterstaat Water Service, <http://www.helpdeskwater.nl/>
[http://www.helpdeskwater.nl/onderwerpen/waterbodems-\(ecb\)/](http://www.helpdeskwater.nl/onderwerpen/waterbodems-(ecb)/)

Rijkswaterstaat, Vision Document on Marine Dredged Material, 2006
http://www.sednet.org/download/RWS_Zoute_Bagger_EN.pdf

2.3 Belgium

The MMM Act on the protection of the marine environment in sea areas under Belgian jurisdiction from 1999 represents the current legal document for dredged material.

All values for metals and TBT given in the table are referring to dry solids. PCB, mineral oil and PAK values refer to the total organic carbon content of each sample.

Metals	Substance	Unit	Target		Limit	
	Arsenic (As)	mg/kg	20	Guidance Level	100	Threshold Value
	Lead (Pb)	mg/kg	70		350	
	Cadmium (Cd)	mg/kg	2,5		7	
	Chromium (Cr)	mg/kg	60		220	
	Copper (Cu)	mg/kg	20		100	
	Nickel (Ni)	mg/kg	70		280	
	Mercury (Hg)	mg/kg	0,3		1,5	
	Zinc (Zn)	mg/kg	160		500	

Organic Contaminants	Substance	Unit	Target		Limit	
	Sum PCB ₇ [*]	µg/g _{OC}	2	Guidance Level	2	Threshold Value
	TBT	µg/kg	3		7	
	Mineraloil	mg/g _{OC}	14		36	
	PAH ₁₀ ^{**}	µg/g _{OC}	70		180	

* PCB 28, 52, 101, 118, 138, 153, 180

** Anthracen, Benz-a-anthracen, Benz-ghi-perylen, Benz-a-pyren, Chrysen, Flouranthen, Indeno-1,2,3-cd-pyren, Phenanthren, Naphthalene, Benzo-k-flouranthene

Deduction of values

All values (guidance levels and threshold values) are derived on an ecotoxicological basis. Various studies concerning the methodology and the derivation of action levels in other countries have been implemented. Mostly these studies are based on literature values. Further the background values of the selected contaminants in seawater and sediments were investigated and an appropriate adjustment of the guidance values was done. Finally these values have been evaluated using bioaccumulation functions for seabirds and humans.

Sampling

Average values are calculated from the analysis of 10 single samples and compared with the values given in the table. A detailed guideline on the sampling procedure for the characterization of beds of watercourses is published by the Water Department in Brussels (2000).

Interpretation

Case I

If analysis results remain below the guidance level, approval for sea disposal can be granted.

Case II

If three threshold values are exceeded, a sea disposal license will not be granted.

Case III

If the analysis results are in between guidance level and threshold level, it is suggested to increase the number of samples by factor x5 and carry out a new analysis. If this second analysis shows a lower contamination, a permit may be given. If the first result gets confirmed with the higher number of samples, additional bioassays should be used following international standard procedures. The results of these tests are seen as a decision support measure. It is not a criterion for exclusion of disposal at sea (MUMM).

Scope of action

Threshold values are defined that allow an exceedance, if no more than two parameters are of concern. Further specifications on how high this exceedance may be is not given.

Sources

Management Unit of the North Sea Mathematical Models - <http://www.mumm.ac.be>

SedNet - Management of Sediment Resources Volume 2, Dessel, G.v., Cnudde, T. 2004

OSPAR Environmental Impact of Human Activities (EIHA) - Info 03/3/2

Characterising the beds of Flemish Watercourses: a Manual, TRIADE, 2000, Publisher: Water Department, Brussels

2.4 France

The handling of dredged material in France is regulated by the French National Water Law. For the marine water, the Interdepartmental Order dated June 14th, 2000 specifies two guidance levels (N1 and N2) for the chemical contents (metals, PCB and recently TBT). These guidance levels, proposed by the Working Group GEODE, were adopted by France within the framework of the OSPAR convention. PAH guidance levels are now under discussion. For the freshwater, a guidance level S1 was established in 2006 as part of the water nomenclature of the French National Water Law.

All values for metals and TBT given in the table are referring to dry solids (< 2mm).

Metals	Substance	Unit	N1	N2	S1	Guidance Level
	Arsenic (As)	mg/kg	25	50	30	
	Lead (Pb)	mg/kg	100	200	100	
	Cadmium (Cd)	mg/kg	1,2	2,4	2	
	Chromium (Cr)	mg/kg	90	180	150	
	Copper (Cu)	mg/kg	45	90	100	
	Nickel (Ni)	mg/kg	37	74	50	
	Mercury (Hg)	mg/kg	0,4	0,8	1	
	Zinc (Zn)	mg/kg	276	552	300	

Organic Contaminants	Substance	Unit	N1	N2	S1	Guidance Level
	PCB 28	µg/kg	25	50	-	
	PCB 52	µg/kg	25	50	-	
	PCB 101	µg/kg	50	100	-	
	PCB 118	µg/kg	25	50	-	
	PCB 138	µg/kg	50	100	-	
	PCB 153	µg/kg	50	100	-	
	PCB 180	µg/kg	25	50	-	
	PCB totals (209)	µg/kg	500	1000	690	
	TBT	µg/kg	100	400	-	
	PAH total	µg/kg	-	-	22800	
	Acenaphthene	µg/kg	100	-	-	
	Anthracene	µg/kg	500	-	-	
	benz[a]anthracene	µg/kg	700	-	-	
	benzo[a]pyrene	µg/kg	200	1000	-	
	benzo[a,h]anthracene	µg/kg	100	-	-	
	benzo[b]fluoranthene	µg/kg	300	3000	-	
	benzo[g,h,i]perylene	µg/kg	150	1000	-	
	benzo[k]fluoranthene	µg/kg	150	2000	-	
	Chrysene	µg/kg	1000	-	-	
	Fluoranthene	µg/kg	400	5000	-	
	Fluorine	µg/kg	200	-	-	
	indeno[1,2,3-cd]pyrene	µg/kg	200	1000	-	
	Naphthalene	µg/kg	200	-	-	
	Phenanthrene	µg/kg	1000	-	-	
	Pyrene	µg/kg	1500	-	-	

Eco-Toxicity	Bio-Assays Used in cases where RFQ N2 is exceeded for one substance or in case of level between N1 and N2 when "GEODRISK" score exceeded 1
	Oyster Embryotoxicity Copepod Mortality Test <i>Corophium</i> Mortality Test Microtox Solid Phase Test

Deduction of values

In France, the strategy for the elaboration of the guide values is based on a statistical exploitation of the contents of metals, measured during the multiannual campaigns. The examination of the distribution of the results allows to determine the value "background noise", that is the natural content without recognizable anthropological contribution.

Interpretation

1) Marine Water

Case I

N1 is the level below which dredging and relocation activities would be authorised without further investigations: the possible impact is thought to be neutral or insignificant as the measurement observed appear to be similar to natural "background noises".

Case II

Between the levels N1 and N2, a complementary investigation could be necessary depending on the considered project and on by how much the level N1 has been exceeded. Therefore, tests are done to assess the global toxicity of sediments.

Case III

N2 is the level above which relocation activities could be forbidden should this prohibition be the less harmful solution for the environment: further investigation generally needs to be done as some clues are a sure sign of possible negative impact of the operations. Then an in-depth impact survey must be done.

2) Freshwater

The guidance levels are precised in an order dated August 9th, 2006. This order also fixes the levels to be taken into account for an analysis of sediments extracted from waterways. They were established to estimate the incidence of an operation on the aquatic environment. It concerns heavy metals, total PCB (Polychloro-Biphenyls) and PAH (Polycyclic Aromatic Hydrocarbon).

S1 makes reference to values mainly determined on an ecotoxicological basis, whereas N1 and N2 mainly derive from statistical processing of physical and chemical data.

Scope of action

Risk assessment is used as a decision support tool (“GEODRISK”), to determine the necessary extend of additional tests. Hence, exceeding one or more of the guidance levels is possible in specific cases.

Sources

French Environmental Code (Book II – physical environments – art . L214, R214)

Order dated June 14th, 2000

Order dated August 9th, 2006

Order dated December 23rd, 2009

Assessment of dredged material for relocation in France, Institute Maritime Waterways Studies (CETMEF), 2007

Dredging in Marine Environment, Dumping and the Environmental Code: procedures guidelines, CETMEF, 2008

Annual survey on dredging activities, CETMEF, 2008

H14 test for sediments: presentation of the protocol proposed for ratification by the MEEDDM “Hazardous vs. non-hazardous sediments” Working Group and brief rationale of the choices made, BRGM/MEEDDM/CEMAGREF/INERIS, 10/2009

Conclusions of the Working Group of GEODE (Group of Studies and Observations on Dredging and the Environment), 2007

2.5 United Kingdom (England and Wales)

The Food and Environmental Protection Act FEPA (II), 1985 is the legal basis for the handling of dredged material in England and Wales, the guidance values have been updated in 1995. The current legislation was updated in 2003 to a revised set of action levels, but these are not yet implemented.

2.5.1 Current Legislation

All values given in the table are referring to dry solids.

Metals	Substance	Unit	AL 1	AL 2	Guidance Level
	Arsenic (As)	mg/kg	20	100	
	Lead (Pb)	mg/kg	50	500	
	Cadmium (Cd)	mg/kg	0,4	5	
	Chromium (Cr)	mg/kg	40	400	
	Copper (Cu)	mg/kg	40	400	
	Nickel (Ni)	mg/kg	20	200	
	Mercury (Hg)	mg/kg	0,3	3	
	Zinc (Zn)	mg/kg	130	800	

Organic Contaminants	Substance	Unit	AL 1	AL 2	Guidance Level
	Sum PCB*	µg/kg	20	200	
	TBT+DBT+MBT	µg/kg	100	1000	
	Total Hydrocarbons	mg/kg	100		

* PCB congeners 18, 28, 31, 44, 47, 49, 52, 66, 101, 105, 110, 118, 128, 138, 141, 149, 151, 153, 156, 158, 170, 180, 183, 187, 194

Deduction of values

The lower action levels (AL1) are based on the background concentration in UK estuaries and represent chemically determined values. Upper action levels (AL2) are based on ecotoxic investigations implemented in the US.

2.5.2 UK Revised Action Levels

In 2003 a new set of action levels has been presented as revised action levels for England and Wales (DEFRA, 2003). These are still not in use.

All values given in the table are referring to dry solids.

	Substance	Unit	revised	revised	
			AL 1	AL 2	
Metals	Arsenic (As)	mg/kg	20	70	Guidance Level
	Lead (Pb)	mg/kg	50	400	
	Cadmium (Cd)	mg/kg	0,4	4	
	Chromium (Cr)	mg/kg	50	370	
	Copper (Cu)	mg/kg	30	300	
	Nickel (Ni)	mg/kg	30	150	
	Mercury (Hg)	mg/kg	0,25	1,5	
	Zinc (Zn)	mg/kg	130	600	

	Substance	Unit	revised	revised	
			AL 1	AL 2	
Organic Contaminants	Sume PCB*	µg/kg	20	180	Guidance Level
	TBT+DBT+MBT	µg/kg	100	500	
	PAH total	mg/kg	100		
	Acenaphthene	mg/kg	0,1		
	Acenaphthylene	mg/kg	0,1		
	Anthracene	mg/kg	0,1		
	Fluorene	mg/kg	0,1		
	Naphthalene	mg/kg	0,1		
	Phenanthrene	mg/kg	0,1		
	Benzo[a]anthracene	mg/kg	0,1		
	Benzo[b]fluoranthene	mg/kg	0,1		
	Benzo[k]fluoranthene	mg/kg	0,1		
	Benzo[g]perylene	mg/kg	0,1		
	Benzo[a]pyrene	mg/kg	0,1		
	Benzo[g,h,i]perylene	mg/kg	0,1		
	Dibenzo[a,h]anthracene	mg/kg	0,01		
	Chrysene	mg/kg	0,1		
	Fluoranthene	mg/kg	0,1		
	Pyrene	mg/kg	0,1		
	Indeno (1,2,3cd)pyrene	mg/kg	0,1		

* PCB congeners 18, 28, 31, 44, 47, 49, 52, 66, 101, 105, 110, 118, 128, 138, 141, 149, 151, 153, 156, 158, 170, 180, 183, 187, 194

** Booster biocide and brominated flame retardants: provisional action levels to these compounds are subject to further investigation

Sampling

No information is available on sampling.

Interpretation

The weight of evidence system for licensing deposits to the marine environment uses geochemical concentrations as one line of evidence. Action levels do not constitute 'pass/fail' thresholds.

In general a case by case decision is made regarding the permit for disposal and relocation.

Case I

Contaminant concentrations below action level AL1 are generally considered of no concern with their potential to cause pollution

Case II

Material with contaminant concentrations between AL1 and AL2 are likely to require further consideration either by additional sampling and analysis, testing (possibly by bioassay) or a change to the proposed dredge/placement method.

Case III

Contaminant concentrations above AL2 are (generally) considered to be unsuitable for sea disposal and will most likely require additional investigation and consideration, which may include treatment management practices.

Scope of action

England and Wales use an integrated weight of evidence system which also considers bioassays and historical aspects of disposal sites. Action levels are just one component in this system for the licensing of dredged material at sea.

Sources

DEFRA CSG15: The Use of Action Levels, Project Code AE0258, 3/2003

http://randd.defra.gov.uk/Document.aspx?Document=AE0258_1937_FRP.doc

DEFRA Contaminated dredged marine sediments

<http://www.defra.gov.uk/environment/marine/protect/licensing/cdms/>

2.6 Ireland

The guideline for the “Assessment of Dredged Material for Disposal in Irish Waters, 2006” is the current legal document available.

All values given in the table are referring to dry solids.

Metals	Substance	Unit	AL 1	AL 2	Guidance Level
	Arsenic (As)	mg/kg	9	70	
	Lead (Pb)	mg/kg	60	218	
	Cadmium (Cd)	mg/kg	0,7	4,2	
	Chromium (Cr)	mg/kg	120	370	
	Copper (Cu)	mg/kg	40	110	
	Nickel (Ni)	mg/kg	21	60	
	Mercury (Hg)	mg/kg	0,2	0,7	
	Zinc (Zn)	mg/kg	160	410	

Organic Contaminants	Substance	Unit	AL 1	AL 2	Guidance Level
	PCB 28	µg/kg	1	180	
	PCB 52	µg/kg	1	180	
	PCB 101	µg/kg	1	180	
	PCB 118	µg/kg	1	180	
	PCB 138	µg/kg	1	180	
	PCB 153	µg/kg	1	180	
	PCB 180	µg/kg	1	180	
	Sum PCB ₇	µg/kg	7	1260	
	γ - Hexachlorcyclohexane	µg/kg	0,3	1	
	Hexachlorbenzene	µg/kg	0,3	1	
	TBT+DBT	mg/kg	0,1	0,5	
	Total Extractable Hydrocarbon	mg/kg	1000		
	PAH ₁₆	µg/kg	4000		

Deduction of values

The lower action levels (AL1) are based on the background concentration in Irish coastal estuaries. Action levels for non existing values have been determined ecotoxicologically; they represent the no-effect concentration. Upper action levels have also been determined ecotoxicologically.

Sampling

The number of samples should at least meet the minimum number given by OSPAR. Sampling sites are dictated by Marine Institute, on behalf of the EPA¹. Basically samples are analysed in the fraction < 2mm, in critical cases it may be required to analyse directly in the fine fraction < 63 µm.

Interpretation

Case I

If analysis results remain below action level AL1 it is assumed that no contamination is present and also no biological effects will occur.

Case II

If the analysis results are in between AL1 and AL2, marginal to moderate contamination is present and further analysis is necessary to determine that hazardous state of the material and to delineate the problem area. A decision is made depending on these results.

Case III

Contaminations above AL2 are considered as a severe contamination. Biological and/or toxicological effects on marine organisms are very probable. Hence alternative management options should be considered.

Scope of action

Action levels and “weight of evidence approach” basically do not exclude any option in the first place.

Sources

Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters, Cronin, M.,2006

<http://www.marine.ie/NR/rdonlyres/A90B2D44-594E-4BDF-A58A-682F997C921A/0/Assessmentofdredgematerial2006.pdf>

1 Permitting authority since 2010

2.7 Norway

Norway has implemented a new guideline that uses classification of contaminated sediments in 5 classes, based on ecological risk. These values replace an earlier classification system based on a statistical evaluation of the presence of contaminants in Norwegian sediments.

The new guideline covers metals and organic compounds in sediments but also in water. Five classes have been retained from the previous system, but the number of compounds of interest has been increased. The new classification system is linked to risk assessment guidelines.

All values given in the table are referring to dry solids.

	Substance	Unit	Values				
			C ₁	C ₂	C ₃	C ₄	
Metals	Arsenic (As)	mg/kg	20	52	76	580	Guidance Level
	Lead (Pb)	mg/kg	30	83	100	720	
	Cadmium (Cd)	mg/kg	0,25	2,6	15	140	
	Chromium (Cr)	mg/kg	70	560	5900	59000	
	Copper (Cu)	mg/kg	35	51	55	220	
	Nickel (Ni)	mg/kg	30	46	120	840	
	Mercury (Hg)	mg/kg	0,15	0,63	0,86	1,6	
	Zinc (Zn)	mg/kg	150	360	590	4500	

	Substance	Unit	Values				
			C ₁	C ₂	C ₃	C ₄	
Organic Contaminants	PAH ₁₆	µg/kg	300	2000	6000	20000	Guidance Level
	Sum PCB ₇	µg/kg	5	17	190	1900	
	PCDD/F (TEQ)	µg/kg	0,01	0,03	0,1	0,5	
	Sum DDT/DDD/DDE	µg/kg	0,5	20	490	4900	
	Lindan	µg/kg		1,1	2,2	11	
	Hexachlorbenzene (HCB)	µg/kg	0,5	17	61	610	
	Pentachlorbenzene	µg/kg		400	800	4000	
	Trichlorbenzen	µg/kg		56	700	1400	
	Hexaklorbutadien	µg/kg		49	66	660	
	SCCP (Chlorparafin)	µg/kg	1000	2800	5600	5600	
	MCCP	µg/kg		4600	27000	54000	
	Pentaklorphenol (PCP)	µg/kg		12	34	68	
	Oktylphenol	µg/kg		3,3	7,3	36	
	Nonylphenol	µg/kg		18	110	220	
	Bisphenol A	µg/kg		11	79	790	
	Tetrabrombisphenol A	µg/kg		63	1100	11000	
	Pentabromdiphenylether	µg/kg		62	7800	16000	
	Hexabromcyclododecan	µg/kg	0,3	86	310	610	
	Perfluorooctansulfonat	µg/kg	0,17	220	630	3100	
	Diuron (DCMU)	µg/kg		0,71	6,4	13	

	Substance	Unit	Values				Guidance Level
			C ₁	C ₂	C ₃	C ₄	
	Cybutryn (Irgarol)	µg/kg		0,08	0,5	2,5	
	TBT effektbasiert	µg/kg		0,002	0,016	0,032	
	TBT	µg/kg	1	5	20	100	

Deduction of values

The scientific basis for the definition of the classes is based on toxicity. Information is gathered from many sources; the EU Water Framework Directive, e.g. on priority substances and Environmental Quality Standards, the Technical Guidance Document on Risk Assessment (EC 2003) and other sources include OSPAR, US EPA, and scientific literature. A background document has been prepared that presents the basis for the classification of the various compounds in water and sediment.

Sampling

Sampling requirements are dependent on the size of the dredging operation. For characterisation purposes a minimum of 5 samples representing not more than 50.000 m² sediment surface or 50.000 m³ dredged material are generally required. Median values of contaminant levels in these samples are used for classification purposes.

Interpretation

The assessment system in Norway is developed to assess the environmental risk of in-situ sediments and determine the need for remediation. Contaminant levels in sediments are divided into 5 classes. The following table is used to classify dredged material:

Guidance Values		
< C1	Class I	Background concentration
C1 - C2	Class II	Good
C2 - C3	Class III	Moderate
C3 - C4	Class IV	Bad
> C4	Class V	Very bad

Basically exceedance of class II triggers Tier II of the sediment risk assessment guideline.

Tier I General guideline values to assess sediment quality (class II)

Tier II Risk of transport, risk to human health and local ecosystem

Tier III Site specific characterisation of risk

Maintenance dredging

The local counties have authority to regulate maintenance dredging operations. This means that there are local differences. In general sediments in class I and II can be disposed of in the marine environment. Disposal of sediments in class III requires further evaluation of potential risk to the environment. Handling of sediments in class IV and V require site specific remediation plans and extensive monitoring during operations.

Scope of action

The classification system gives guideline values of a general nature. For large scale dredging operations site specific risk assessment is required. This will form the basis for remediation plans and possible disposal options.

Sources

Development of Sediment Quality Criteria in Norway, Bakke, T., Proceedings SedNet Conference 2008

<http://www.sednet.org/download/conference2008/4%20Torgeir%20Bakke.pdf>

SedNet - Management of Sediment Resources. Volume 2, Hauge, A. 2004

Classification of Environmental Quality in Fjords and Coastal Waters", SFT-TA 2227/2007

2.8 Denmark

In 2005 a 3-category system with 2 levels of action values was developed and published 1. October 2005 as Guideline No. 9607 on dumping of dredged materials – later revised in Guideline No. 9702 from the 20. October 2008 on dumping of dredged material by the Agency for Spatial and Environmental Planning, Ministry of the Environment.

All values given in the table are referring to dry solids.

Metals	Substance	Unit	AL 1	AL 2	Guidance Level	
	Arsenic (As)	mg/kg	20	60		
	Lead (Pb)	mg/kg	40	200		
	Cadmium (Cd)	mg/kg	0,4	2,5		
	Chromium (Cr)	mg/kg	50	270		
	Copper (Cu)	mg/kg	20	90		200 kg / harbour/year
	Nickel (Ni)	mg/kg	30	60		
	Mercury (Hg)	mg/kg	0,25	1		
Zinc (Zn)	mg/kg	130	500			

Org. Contaminants	Substance	Unit	AL 1	AL 2	Guidance Level
	Sum PCB ₇	µg/kg	20	200	
	PAK ₉ *	µg/kg	3	30	
TBT	µg/kg	7	200	1 kg / harbour/year	

* PAK: Anthracen, Benz[a]anthracen, Benz[ghi]perylene, Benz[a]pyren, Chrysen, Fluoranthen, Indeno[1,2,3-cd]pyren, Pyren, Phenanthren

Deduction of values

The Danish action levels are based on data from the Netherlands and Finland. Some adjustments to Danish circumstances have been made. The lower action levels correspond to background levels or levels of expected no-effect. The upper action levels are based on international recognised levels, which mean that ecotoxicological data are taken into account.

Sampling

No information available on sampling.

Interpretation

Case I

If chemical analysis of the material to be disposed shows concentrations below AL1 a permit for disposal can be given without further specific evaluations - taking into account proper site selection.

Case II

If the chemical analysis shows concentrations of contaminants between the two action levels a more comprehensive study and evaluation has to be carried out, based on the amount to be disposed and the concentrations of contaminants. An exceedance of the upper action level of up to 50% for cadmium and mercury still allows a classification as case II. Additionally there a fraction limitation for copper and TBT that allow an exceedance of the upper action level if the total annual amount is below the given total fraction.

Case III

If the chemical analysis shows concentrations above the upper action levels disposal at sea will normally not be permitted, pending a throughout evaluation of the case, and the material must be deposited at land.

Scope of action

Only a very limited number of organic parameters are regulated.

Sources

Vejledning fra By- og Landskabsstyrelsen Dumpning af optaget havbundsmateriale – klappning
<https://www.retsinformation.dk/Forms/R0710.aspx?id=121680>

2.9 Spain

There is currently no legal guideline available in Spain, all information given refer to the so called CEDEX guideline which is about to be implemented.

All values given in the table are referring to dry solids, but all values correspond to the fraction < 63 µm.

	Substance	Unit	Level		Group
			C1	C2	
Metals	Arsenic (As)	mg/kg	80	200	B1
	Lead (Pb)	mg/kg	120	600	A
	Cadmium (Cd)	mg/kg	1	5	A
	Chromium (Cr)	mg/kg	200	1000	A
	Copper (Cu)	mg/kg	100	400	A
	Nickel (Ni)	mg/kg	100	400	A
	Mercury (Hg)	mg/kg	0,6	3	A
	Zinc (Zn)	mg/kg	500	3000	A

	Substance	Unit	Level		Group
			C1	C2	
Organic Contaminants	Sum PCB ₇ *	µg/kg	30	100	A
	Sum PCB ₁₆ **	-	-	-	B1
	DDX	-	-	-	B1
	Mineral oil	-	-	-	B1
	AOX	-	-	-	B1
	Phosphororganic pesticides				B2
	TBT				B2
	PAH				B2
	Organosilikon Components				B2
	Specific organic Components				B2
Additional metals				B2	

* PCB 28, 52, 101, 118, 138, 153 und 180

** PCB₇ plus PCB 18, 31, 44, 66/95, 110, 149, 187, 70

Deduction of values

Values are based on various studies focusing on: contaminant background concentration at the Spanish coast, anthropogenic contamination in dredged material, normalization methods, validation of bioassays as well as bioavailability of pollutants in dredged material.

Sampling

The number of samples relative to the area to be dredged is regulated: $N=x/(25*x-1)$;
 x = area in m²

Interpretation (CEDEX)

Case I

If the contamination level does not exceed C1, only the physical effect of disposal needs to be considered.

Case II

If the contamination level exceeds C1 in one or more cases, but does not exceed level C2, a disposal can be considered as long as an appropriate monitoring program will be maintained and an impact analysis has been done.

Case III

If the contamination exceeds value C2, a permit for sea disposal can only be given if a capping or an alternative treatment method is implemented at the same time.

The contaminants are sorted into groups: A, B1 and B2. Usually only parameters of group A are analysed in the first place.

Contaminants of the subgroup B1 need to be considered if:

- (A) guidance value C1 is exceeded for at least 3 metals. In this case Arsenic needs to be analysed additionally.
- (B) guidance value C1 is exceeded for PCB₇ or the total amount of organic carbon amounts to more than 10% of the sample. In this case organic parameters of group B1 have to be analysed additionally.

Contaminants of the subgroup B2 need to be considered if:

Substances of subgroup B2 have to be analysed in relation to the local information on sources of contaminants.

In case three contaminants of group A exceed the limit value C2 by more than 75% or if elevated contaminant concentrations of substances of group B were determined, bioassays have to be implemented additionally to evaluate the effects of dredged material on marine biota. The decision if a permit for disposal will be granted depends on the test results.

Scope of action

The CEDEX guideline is not a legal basis.

Sources

CEDEX - Recommendations for the management of dredged material in the ports of Spain, 1994

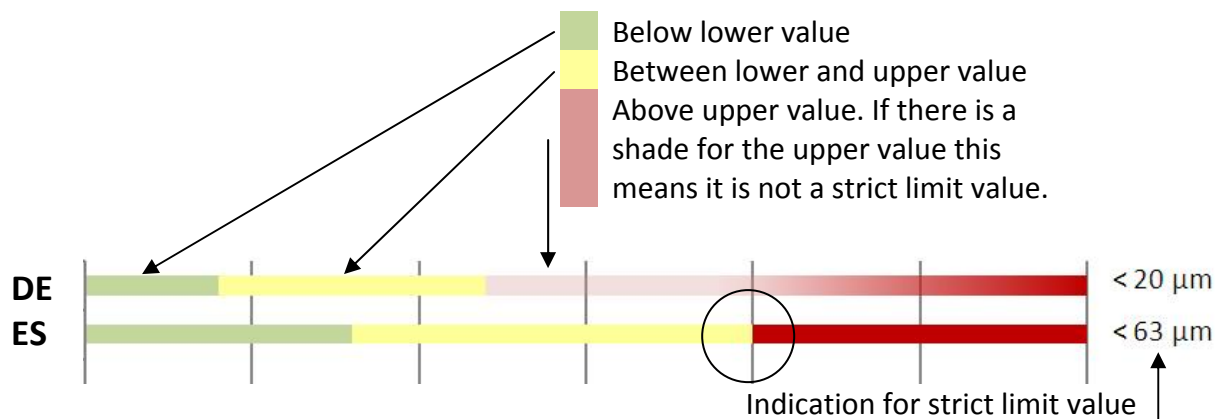
M.C. Casado- Martinez, et al: Using sediment quality guidelines for dredged material management in commercial ports from Spain. Environment International 32 (2006) 388 – 396

[http://docum.azti.es/AZTIIntranet/aztipub.nsf/c4a57dc5ed9257a28025695b00330b27/09674ac4aeb5afd8c12570fc003a3bf0/\\$FILE/EnvInt2006.pdf](http://docum.azti.es/AZTIIntranet/aztipub.nsf/c4a57dc5ed9257a28025695b00330b27/09674ac4aeb5afd8c12570fc003a3bf0/$FILE/EnvInt2006.pdf)

3 Cross national comparison of action levels

From the preceding chapter it has become clear that it is difficult to compare different national values for the same parameter. **In a strict sense a direct comparison of national action levels / standards between different countries cannot be made.** The values are measured or determined in different grain size fractions, they are strict limit values or “softer” guidance values, etc. Nevertheless this is done in this chapter in a graphical way in order to get an impression.

In most cases there are 3 classes:



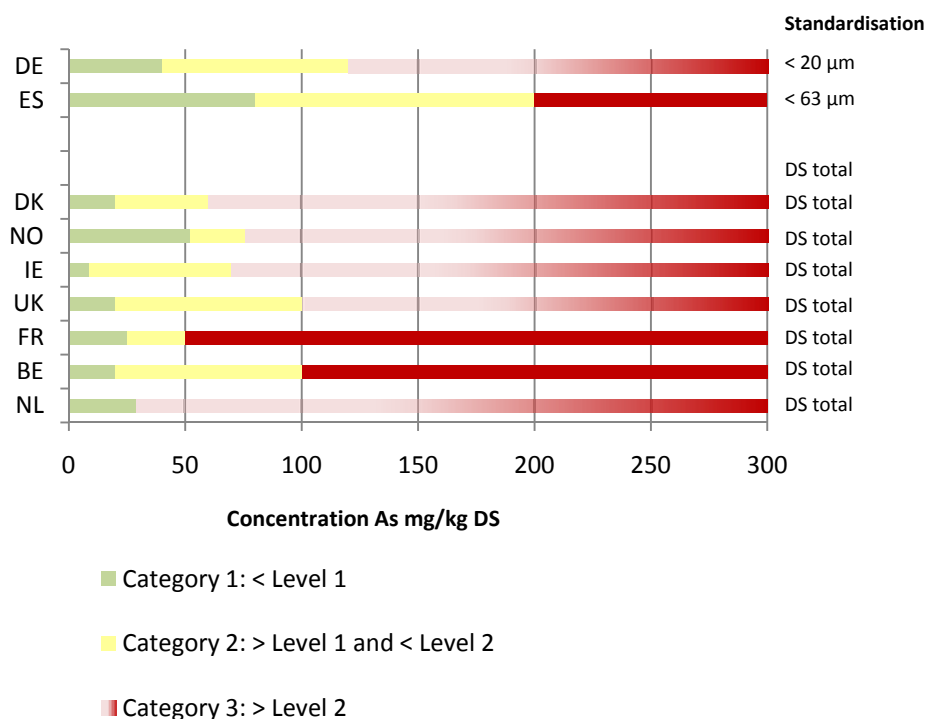
In the table an indication is given for the relevant standardization / grain size fraction.

To be considered: A different system is used in Norway classifying into 5 categories by the use of 4 action levels. For comparison, the figures are based on upper values of class II and III assuming that they can be compared to action levels 1 and 2 used in other European countries.

3.1 Arsenic (As)

Arsenic (As)	Country	Level 1	Level 2	Unit
	NL		29	mg/kg DS
	BE	20	100	mg/kg DS
	FR	25	50	mg/kg DS
	UK	20	100	mg/kg DS
	IE	9	70	mg/kg DS
	NO	52	76	mg/kg DS
	DK	20	60	mg/kg DS
	ES	80	200	mg/kg DS < 63 µm
	DE	40	120	mg/kg DS < 20 µm
Level 1	Minimum	IE	9	mg/kg DS
Maximum	ES	80	mg/kg DS < 63 µm	
	or NO	52	mg/kg DS	
Level 2	Minimum	NL	29	mg/kg DS
Maximum	ES	200	mg/kg DS < 63 µm	

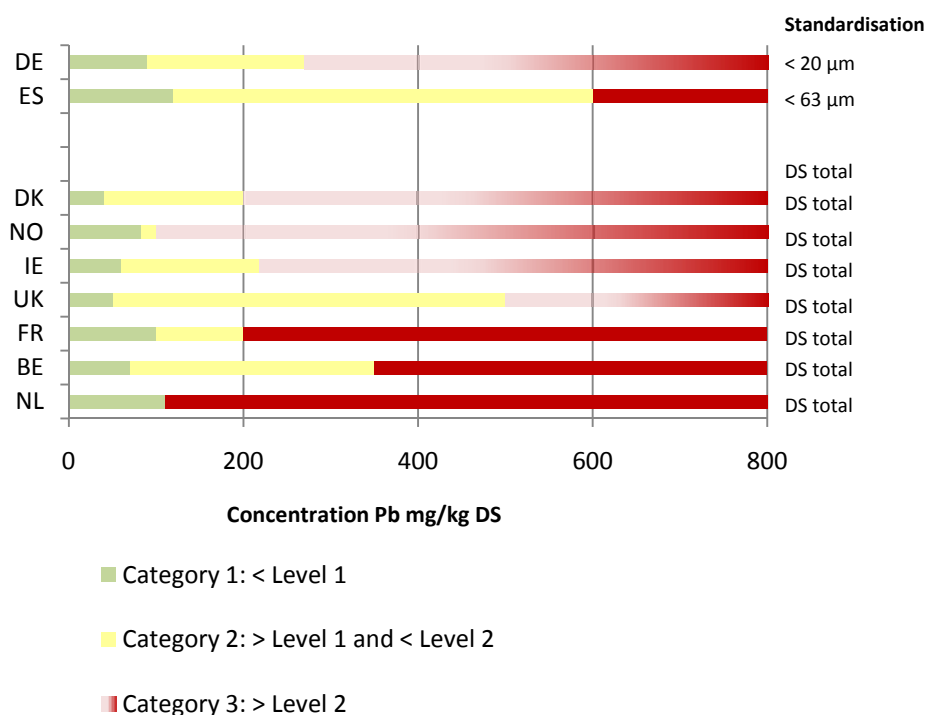
X strict threshold value



3.2 Lead (Pb)

Lead (Pb)	Country	Level 1	Level 2	Unit
	NL		110	mg/kg DS
	BE	70	350	mg/kg DS
	FR	100	200	mg/kg DS
	UK	50	500	mg/kg DS
	IE	60	218	mg/kg DS
	NO	83	100	mg/kg DS
	DK	40	200	mg/kg DS
	ES	120	600	mg/kg DS < 63 µm
	DE	90	270	mg/kg DS < 20 µm
Level 1	Minimum	DK	40	mg/kg DS
Maximum	FR	100	mg/kg DS < 2mm	
	or ES	120	mg/kg DS < 63 µm	
Level 2	Minimum	NO	100	mg/kg DS
Maximum	UK	500	mg/kg DS	
	or ES	600	mg/kg DS < 63 µm	

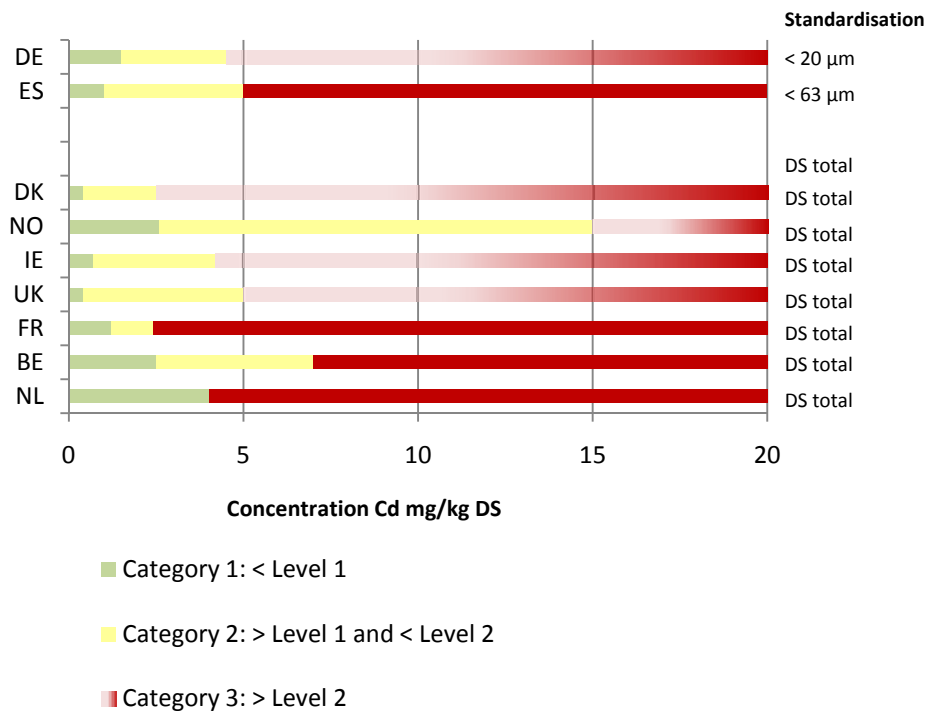
X strict threshold value



3.3 Cadmium (Cd)

Cadmium (Cd)	Country	Level 1	Level 2	Unit
	NL		4	mg/kg DS
	BE	2,5	7	mg/kg DS
	FR	1,2	2,4	mg/kg DS
	UK	0,4	5	mg/kg DS
	IE	0,7	4,2	mg/kg DS
	NO	2,6	15	mg/kg DS
	DK	0,4	2,5	mg/kg DS
	ES	1	5	mg/kg DS < 63 µm
	DE	1,5	4,5	mg/kg DS < 20 µm
Level 1	Minimum	DK	0,4	mg/kg DS
		UK	0,4	mg/kg DS
	Maximum	NO	2,6	mg/kg DS
Level 2	Minimum	FR	2,4	mg/kg DS
	Maximum	NO	15	mg/kg DS

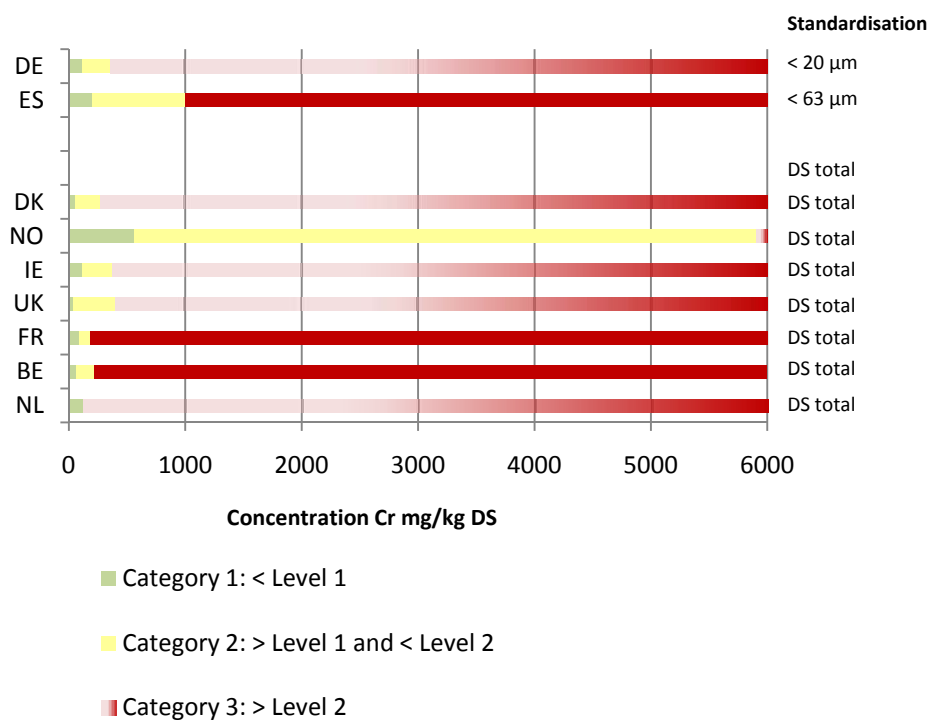
X strict threshold value



3.4 Chromium (Cr)

Chromium (Cr)	Country	Level 1	Level 2	Unit
	NL		120	mg/kg DS
	BE	60	220	mg/kg DS
	FR	90	180	mg/kg DS
	UK	40	400	mg/kg DS
	IE	120	370	mg/kg DS
	NO	560	5900	mg/kg DS
	DK	50	270	mg/kg DS
	ES	200	1000	mg/kg DS < 63 µm
	DE	120	360	mg/kg DS < 20 µm
Level 1	Minimum	UK	40	mg/kg DS
Maximum	NO	560	mg/kg DS	
Level 2	Minimum	NL	120	mg/kg DS
Maximum	NO	5900	mg/kg DS	

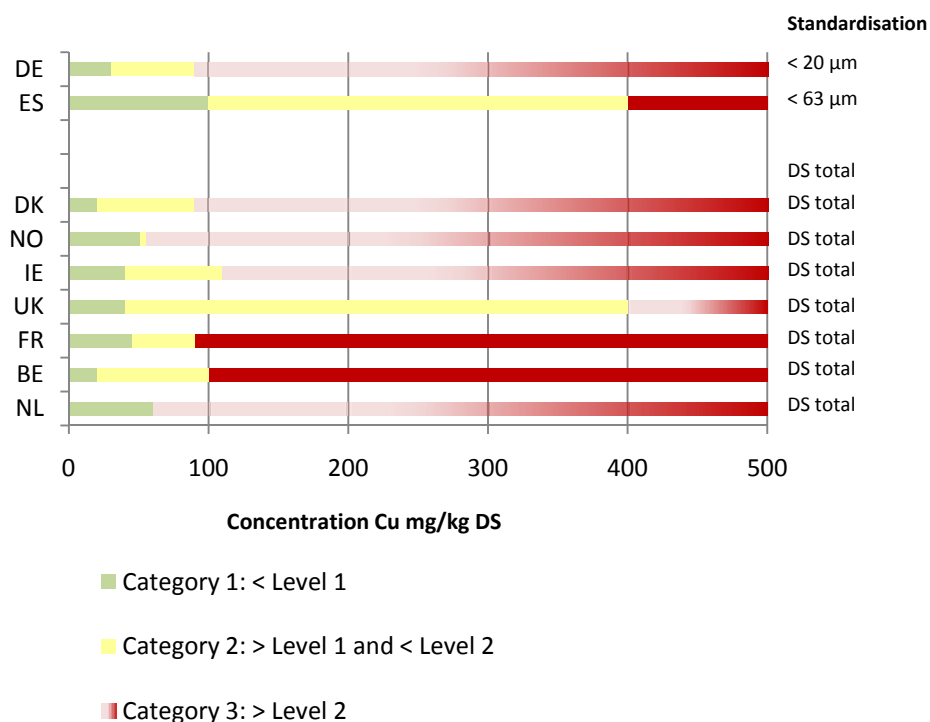
X strict threshold value



3.5 Copper (Cu)

Copper (Cu)	Country	Level 1	Level 2	Unit
	NL		60	mg/kg DS
	BE	20	100	mg/kg DS
	FR	45	90	mg/kg DS
	UK	40	400	mg/kg DS
	IE	40	110	mg/kg DS
	NO	51	55	mg/kg DS
	DK	20	90	mg/kg DS
	ES	100	400	mg/kg DS < 63 µm
	DE	30	90	mg/kg DS < 20 µm
Level 1	Minimum	BE	20	mg/kg DS < 20 µm
Maximum	ES	100	mg/kg DS < 63 µm	
Level 2	Minimum	DE	90	mg/kg DS < 20 µm
		NL	60	mg/kg DS
Maximum	UK	400	mg/kg DS	

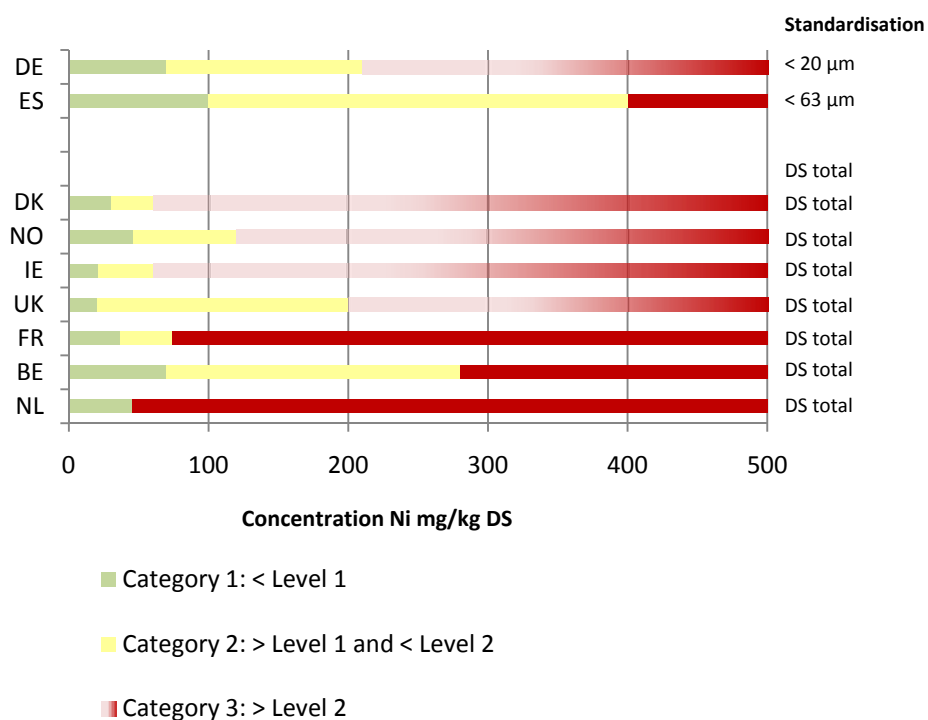
X strict threshold value



3.6 Nickel (Ni)

Nickel (Ni)	Country	Level 1	Level 2	Unit
	NL		45	mg/kg DS
	BE	70	280	mg/kg DS
	FR	37	74	mg/kg DS
	UK	20	200	mg/kg DS
	IE	21	60	mg/kg DS
	NO	46	120	mg/kg DS
	DK	30	60	mg/kg DS
	ES	100	400	mg/kg DS < 63 µm
	DE	70	210	mg/kg DS < 20 µm
Level 1	Minimum	UK	20	mg/kg DS
Maximum	BE	70	mg/kg DS	
		ES	100	mg/kg DS < 63 µm
Level 2	Minimum	NL	45	mg/kg DS
Maximum	ES	400	mg/kg DS < 63 µm	

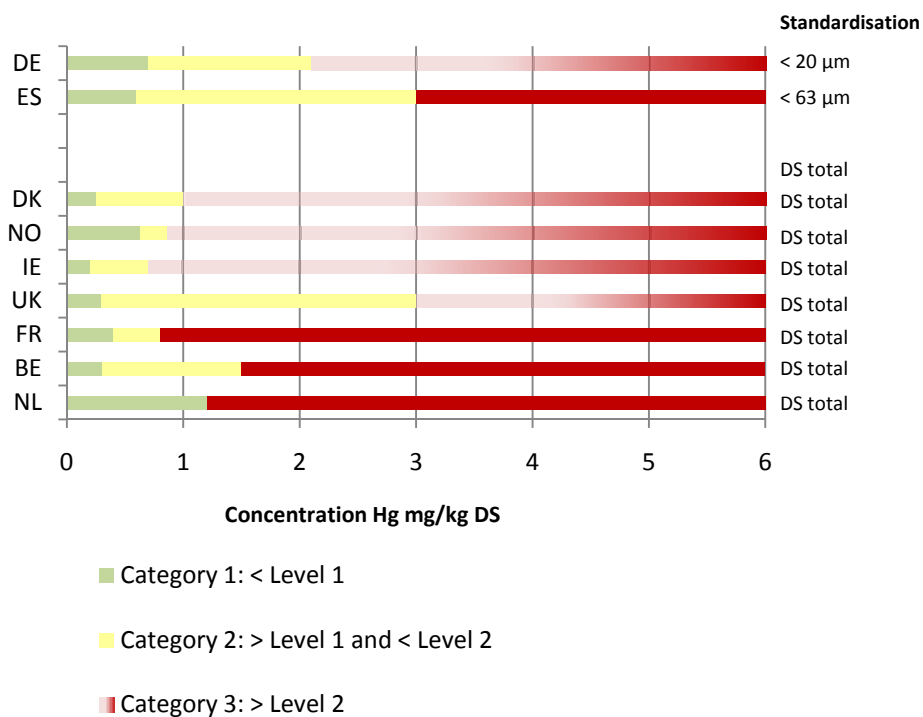
X strict threshold value



3.7 Mercury (Hg)

Mercury (Hg)	Country	Level 1	Level 2	Unit
	NL		1,2	mg/kg DS
	BE	0,3	1,5	mg/kg DS
	FR	0,4	0,8	mg/kg DS
	UK	0,3	3	mg/kg DS
	IE	0,2	0,7	mg/kg DS
	NO	0,63	0,86	mg/kg DS
	DK	0,25	1	mg/kg DS
	ES	0,6	3	mg/kg DS < 63 µm
	DE	0,7	2,1	mg/kg DS < 20 µm
Level 1	Minimum	IE	0,2	mg/kg DS
Maximum	NO	0,63	mg/kg DS	
Level 2	Minimum	IE	0,7	mg/kg DS
Maximum	ES	3	mg/kg DS < 63 µm	

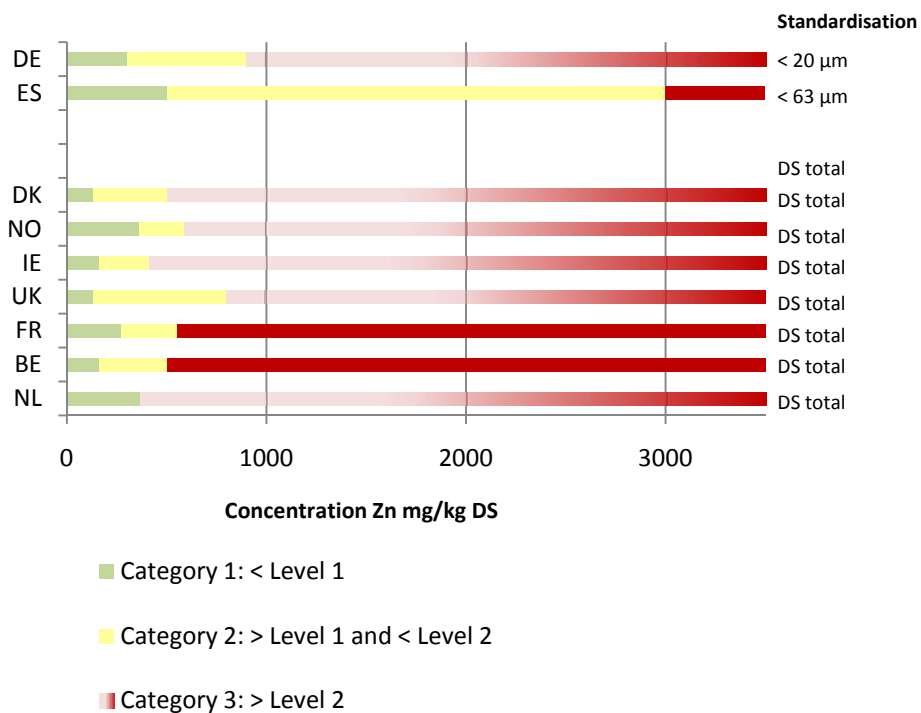
X strict threshold value



3.8 Zinc (Zn)

	Country	Level 1	Level 2	Unit
	Zinc (Zn)	NL		365
BE		160	500	mg/kg DS
FR		276	552	mg/kg DS
UK		130	800	mg/kg DS
IE		160	410	mg/kg DS
NO		360	590	mg/kg DS
DK		130	500	mg/kg DS
ES		500	3000	mg/kg DS < 63 µm
DE		300	900	mg/kg DS < 20 µm
Level 1		Minimum	UK, DK	130
	Maximum	NO	360	mg/kg DS
		or ES	500	mg/kg DS < 63 µm
Level 2	Minimum	NL	365	mg/kg DS
	Maximum	ES	3000	mg/kg DS < 63 µm

X strict threshold value

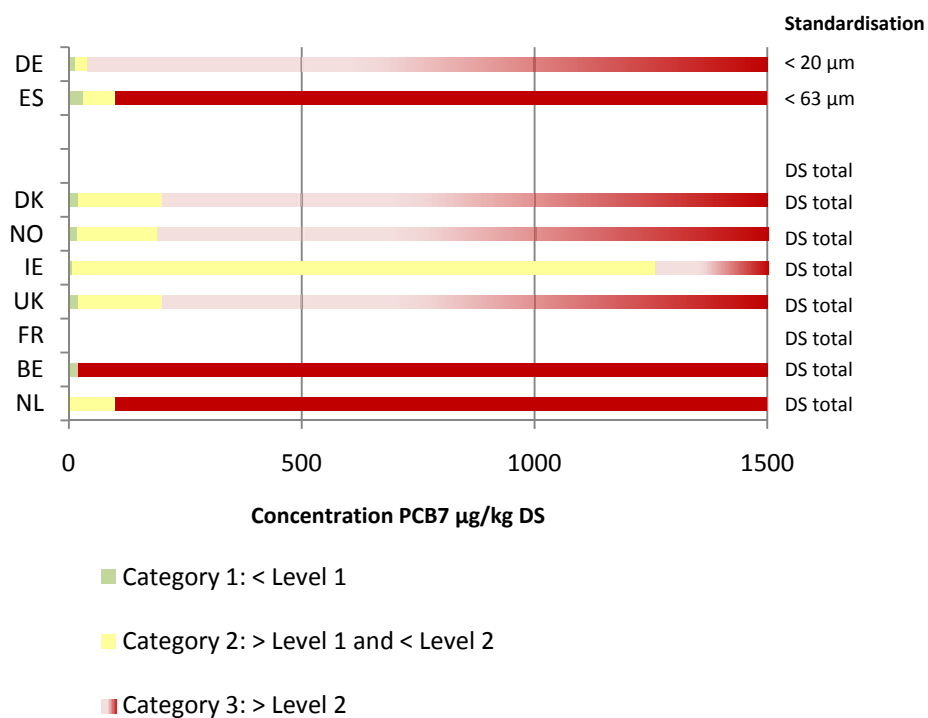


3.9 Polychlorinated Biphenyl (PCB₇)

Polychlorinated biphenyl (PCB ₇)	Country	Level 1	Level 2	Unit
	NL		100	µg/kg DS
	BE*	20	20	µg/g DS
	FR**	250	500	µg/kg DS
	UK	20	200	µg/kg DS
	IE	7	1260	µg/kg DS
	NO	17	190	µg/kg DS
	DK	20	200	µg/kg DS
	ES	30	100	µg/kg DS < 63 µm
	DE	13	40	µg/kg DS < 63 µm
Level 1	Minimum	IE	7	µg/kg DS
	Maximum	FR	250	µg/kg DS
Level 2	Minimum	DE	40	µg/kg DS < 63 µm
	Maximum	IE	1260	µg/kg DS

*B: unit eq. µg/kg org. DS - values calculated assuming 1% org. DS

**F: values deduced from the sum of the 7 individual values



3.10 Tributyltin (TBT)

Tributyltin (TBT)	Country	Level 1	Level 2	Unit	Remarks
	NL		100	µg/kg DS	
	BE	3	7	µg/kg DS	
	FR	100	400	µg/kg DS	
	UK	100	1000	µg/kg DS	sum: TBT + DBT + MBT
	IE	100	500	µg/kg DS	sum: TBT + DBT
	NO	5	20	µg/kg DS	
	DK	7	200	µg/kg DS	
	ES				
	DE	20	100	µg/kg DS	
Level 1	Minimum	BE	3	µg/kg DS < 20 µm	
Maximum	FR	100	µg/kg DS < 2mm		
Level 2	Minimum	BE	7	µg/kg DS < 20 µm	
Maximum	FR	400	µg/kg DS < 2mm		

