Development of sediment quality criteria in Norway

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Content

- Historical development
- Principles of old and new classification
- Information basis
- Challenges
- Link to sediment risk assessment
- Application

Sediment classification in Norway

- 1997: Classification of environmental quality in fjords and coastal waters. A guide (SFT TA-1467/1997)

- Covers seawater, sediments, organisms
  - Eutrophication parameters
  - Contaminants
  - Bacteria
  - Usage of seawater

Sediment parameters covered

- Organic carbon
- Biodiversity of sediment fauna
- Metals
- PAHs
- PCBs
- PCDD/PCDF
- DDT
- HCB

Valid for fine sediments only (silt and clay)

Structure

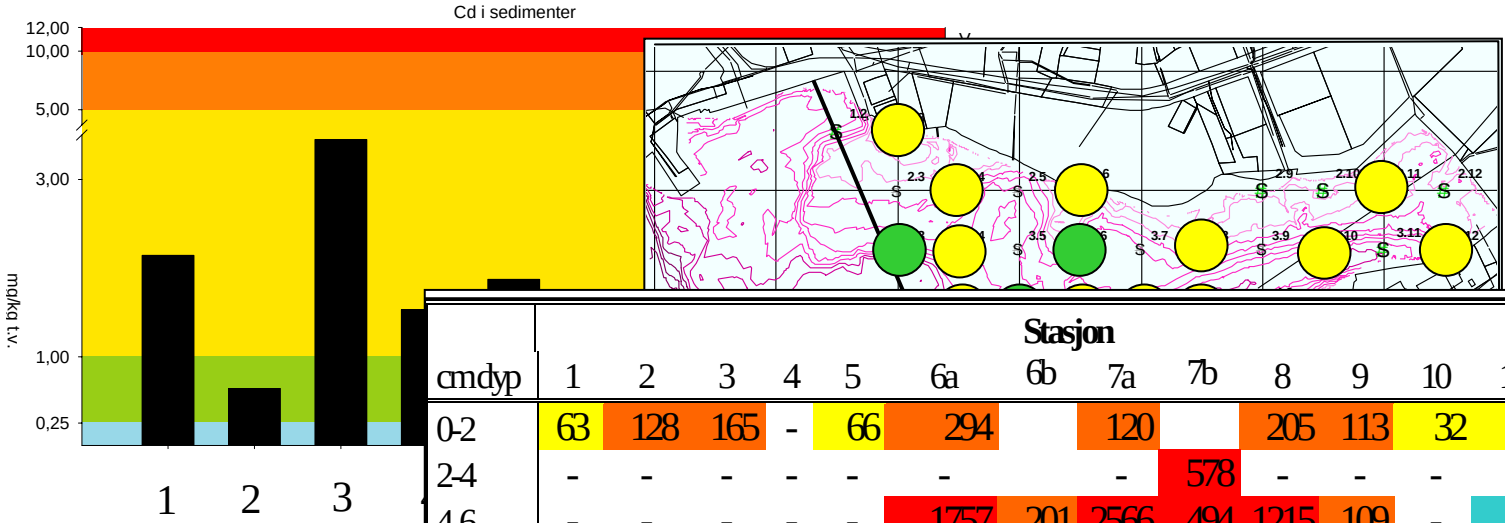
Compound	Class I, Insignificantly polluted	Class II, Moderately polluted	Class III, Markedly polluted	Class IV, Severely polluted	Class V, Extremely polluted
	Background $< C_1$	C_1- C_2	C_2- C_3	C_3- C_4	$> C_4$

- Class I: coastal levels far from point sources or preindustrial levels from deep cores (background)
- Class II – V: overconcentrations relative to Class I
  - Class definition not readily traceable
  - Statistical distribution of concentrations
  - Empirical gradients around point sources
  - Environmental risk properties of individual compounds
  - Health risk (Hg, dioxins)

Example

Substance	Class I Insignficantly	Class II Moderately	Class III Markedly	Class IV Severely	Class V Extremely
Lead mg/kg	< 30	30-120	120-600	600-1 500	> 1 500
Cadmium mg/kg	< 0,25	0,25-1	1-5	5-10	> 10
Copper mg/kg	< 35	35-150	150-700	700-1 500	> 1 500
Mercury mg/kg	< 0,15	0,15-0,6	0,6-3	3-5	> 5
TBT µg/kg	< 1	1-5	5-20	20-100	> 100
Sum PAH_{16} µg/kg	< 300	300-2 000	2 000-6 000	6 000-20 000	> 20 000
Sum PCB_7 µg/kg	< 5	5-25	25-100	100-300	> 300
HCB µg/kg	< 0,5	0,5-2,5	2,5-10	10-50	> 50

Application



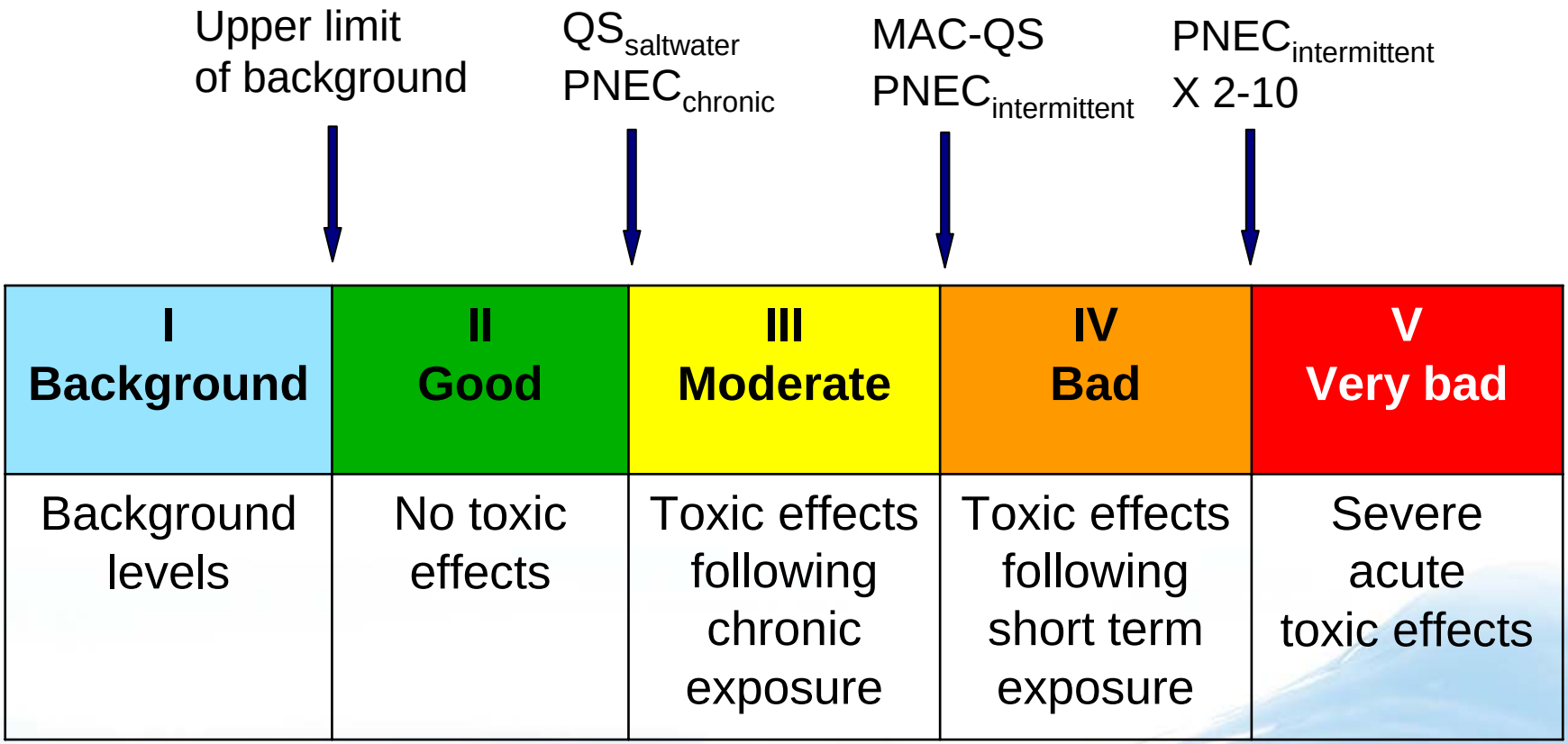
cm dyp	Stasjon 1	2	3	4	5	6a	6b	7a	7b	8	9	10	11	12	13
0-2	63	128	165	-	66	294		120		205	113	32	53	-	125
2-4	-	-	-	-	-	-		-	578	-	-	-	-	-	-
4-6	-	-	-	-	-	1757	201	2566	494	1215	109	-	0	-	-
6-10	-	2	-	-	148	>34637		714	709	216	331	183	10	-	137
10-15	-	-	-	-	67	122	156	69	194	43	485	-	-	-	9
15-20	-	0	-	-	-	6	583	9		5		110	-	-	2
20-25	-	-	-	-	-	397		-		-	-	-	-	-	-
25-30	-	38	-	-	-	-		-		-	-	4	-	-	-

- Use as threshold for cleanup planning
- Acceptance criteria for remediation

System revision 2007

- Guideline for classification of environmental quality in fjords and coastal waters (SFT TA-2229/2007)
- Covers metals and organic contaminants in sediment and water
- Five classes have been retained
- From concentration range to effects based
- Increased number of compounds
- Link to risk assessment guidelines

Toxicity defined classification



Scientific basis for classes

- Primarily from EU:
  - Water Frame Directive
    - Data Sheets for Priority Substances
    - EQS (European Quality Standards)
  - TGD (Technical Guidance Document on Risk Assessment, EC 2003)
    - EU Risk Assessment Reports (RAR)

- Other sources:
  - OSPAR
  - RIVM, the Neterlands
  - US EPA (IUCLID and ECOTOX)
  - Scientific literature

Class definitions 1)

- Class I upper limit:
  - Retained limits from 1997 for existing substances
  - Provisional limits for some new substances based on Norwegian screening surveys
  - For several new substances Class I limits are not established

- Class II upper limit:
  - Equivalent to PNEC for chronic exposure ($PNEC_{sediment,chronic}$)
    - WFD $QS_{sediment}$
    - EU RAR $PNEC_{sediment}$
    - Calculated from $PNEC_{water}$ according to TGD (use of environmental partitioning, application factors and TOC=1%)
    - Species Sensitivity Distribution (chronic SSD) used to calculate $PNEC_{water}$ for metals
    - Not based on bioaccumulation and secondary poisoning

Class definitions 2)

- Class III upper limit:
  - Equivalent to PNEC for intermittent exposure ($PNEC_{sed,\ intermittent}$)
  - No $PNEC_{sed.\ intermittent}$ have been developed by EU RAR or as QS
  - Calculation from $PNEC_{water,intermittent}$ by use of EP
  - Calculation from empirical $PNEC_{sediment,chronic}$ by acute/chronic ratios

- Class IV upper limit:
  - No well defined toxicological basis
  - Calculated as $PNEC_{sediment,intermittent}$ multiplied by the ratio:"upper limit Class IV/upper limit Class III" for water
    - Class IV limit for water is equivalent to Class III limit with lower AFs, or
    - For metals: Class IV limit for water equals 5-percentil (HC_5) in the SSD

- Class V: all concentrations beyond Class IV

Challenges

- Problem 1: lack of tox
  - ➡ Large AFs and hence extre compounds
    - PNECs within background
    - PNECs below analytical re
  - ➡ Large differences in PNEC by differences in available
- Solution: remove AFs
  - AF=2-10 for conversion fr
  - AF=10 for substances with

PAH	Version 1	Version 2
Naphtalene	29	290
Acenaphtylene	3,3	33
Acenaphtene	16	160
9H-Fluorene	26	256
Phenantrene	500	500
Anthracene	30	31
Fluoranthene	12,9	173
Pyrene	140	280
Benzo[a]anthracene	0,6	60
Chrysene	2,8	279
Benzo[b]fluoranthene	24	244
Benzo[k]fluoranthene	174	214
Benzo(a)pyren	250	416
Indeno[123cd]pyrene	4,7	47
Dibenzo[ah]anthrazene	58	585
Benzo[ghi]perylene	2,05	20,5
Average	**79,6**	**224,3**
SD	**133,6**	**170,4**
Variation coefficient 1)	**1,7**	**0,8**

1) SD/average

Challenges

- Problem 2: single compounds and compound groups
  - ➡ Formal Class definition not possible for sumPCB_7, sumPAH_{16} and sumTEQ for PCDD/PCDF
  - ➡ Toxicity is dependent on relative composition and variable Kd

- Solution:
  - For sumPAH_{16} and PCDD/PCDF the 1997 classification is retained
  - For sumPCB_7 a US toxicity based classification is adopted [1)]

1) MacDonald et al. 2000

For practical management reasons the 1997 classification for TBT is also retained.

Old vs new classification

	Class I	Class II	Class III	Class IV
Lead mg/kg	< 30 **< 30**	30-120 **30 -83**	120-600 **83-100**	600-1500 **100-720**
Cadmium mg/kg	< 0,25 **< 0.25**	0,25-1 **0,25-2,6**	1-5 **2,6-15**	5-10 **15-140**
Copper mg/kg	< 35 **< 35**	35-150 **35-51**	150-700 **51-55**	700-1500 **55-220**
Mercury mg/kg	< 0,15 **< 0.15**	0,15-0,6 **0,15-0.63**	0,6-3 **0,63-0.86**	3-5 **0,86-1.6**
sumPCB_7 µg/kg	< 5 **< 5**	5-25 5-**17**	25-100 **17-190**	100-300 **190-1900**
sumDDT µg/kg	< 0,5 **< 0,5**	0,5-2,5 **0,5-20**	2,5-10 **20-490**	10-50 **490-4900**

Additional substances

- Individual PAH_{16} compounds
- Chlorinated alkanes
- Chlorinated phenols
- Chlorinated benzenes
- Alkyl phenols
- Brominated flame retardants
- PFOS
- Biocides (Irgarol, Diuron)

Link to sediment risk assessment

I Background	II Good	III Moderate	IV Bad	V Very bad
Background levels	No toxic effects	Toxic effects following chronic exposure	Toxic effects following short term exposure	Severe acute toxic effects

Sediment risk assessment guideline	Tier 1 Risk to sediment ecosystem	Tier 2 Risk of spreading, Risk to human health and local ecosystems	Tier 3 Site specific reassessment according to Tier 2

Exceedance of Class II triggers Tier 2

Implication of the revision

- Reclassification will seldom be done
- Both systems will be in use for a period
  - Implementation takes time
  - Serves different purposes
- Clear reference to the system used is required
  - SFT TA-1467/1997 and TA-2229/2007

Thank you.