Sediment Environmental Quality Standards in application of the Water Framework Directive: a continuing challenge

Marc BABUT
Freshwater Systems, Ecology and Pollution / Ecotoxicology lab. (Lyon, France)
A long / difficult process

• 2005: first guidance issued
  – Freshwater ⇒ based upon the “TGD”, namely
    • Ecotoxicological tests + assessment factors
    • Equilibrium partitioning
  – Transitional and coastal waters ⇒ same
    • Ecotoxicological tests + assessment factors
    • AF increased as compared to freshwaters
  – For some substances, lack of data
  – No sediment EQS issued
• 2005-2010 Priority substances list revision process
• Priority substances directive
• 2007-2009 EG-EQS
• 2010 –EG “on review”

Lepper P. (2005) Manual on the methodological framework to derive EQS for priority substances in accordance with Art. 16 of the WFD – Fraunhofer Institute, 51 p
A long (...) process (2)

Status box

Title:
Technical Guidance Document for deriving Environmental Quality Standards

Version: Draft version 5.0 (29 January 2010)

Background:
Under the WFD Common Implementation Strategy, an Expert-Group (EG) on Environmental Quality Standards (EQS) was initiated in 2007 to produce guidance on establishment of the EQSs in the field of water policy. This activity is led by UK and the JRC and supported by the Working Group E (WG-E).

The first draft guidance was prepared and sent for consultations to the national expert network of EG-EQS and WG members (Member States, stakeholders and NGOs) in December 2008. A new version compiling the comments received was consulted with WG E members from September till October 2009 and with SCG members afterwards. A revised version of the guidance was produced in early December 2009 based on the comments/suggestions received and sent for consultation to the WG E members. An extraordinary meeting of WG E was organised on the 12 of January 2010 to assess and agree the latest version produced. Comments made at this meeting and submitted afterwards in writing (an overview of the comments and treatments is available on CIRCA under WG E folders) are incorporated in the current version of the guidance (version 5.0).

Request to Strategic Coordination Group:

The SCG is invited to:
• take note of the draft version of the guidance
• discuss this version at the meeting of 23 February 2010
• submit editorial comments until 2 March 2010
• discuss and agree that a final draft version will be presented to the Water Directors for their endorsement during their meeting in Spain on 27-28 May 2010.

Follow-up:
After guidance’s endorsement by SCG members, a mandate will be prepared by the Commission in order to allow consultation with Scientific Committee on Health and Environmental Risks (SCHER) and other Commission Services.

Contact points:
Ana PAYA PEREZ (Ana.PAYA-PEREZ@ec.europa.eu), Paul WHITEHOUSE (paul.whitehouse@environment-agency.gov.uk), Helen WILKINSON (helen.wilkinson@environment-agency.gov.uk), Jorge RODRIGUEZ ROMERO (Jorge.RODRIGUEZ-ROMERO@ec.europa.eu) and Madalina DAVID (Madalina.DAVID@ec.europa.eu)

• Dec. 2008: draft guidance sent to MS for consultation
• Sep.-Oct. 2009: commented version / WG E
• Dec. 2009: revised version
• Jan. 2010: agreed version (5.0)

• Adoption by the Water Directors by the end of May 2010 (?)
• SCHER consultation

• Application (test)
• Revised priority list and EQS by the end of 2010
Overview of the EQS derivation guidance document

1. Generic issues
   - Receptors & compartments at risk
   - Overall standard
   - Data-acquiring, evaluating and selecting data
   - …

2. Water: AA- and MAC-QS
   - General process
   - Metals: bioavailability corrections, background concentrations …

3. Biota
4. (sediment)
5. Non testing approaches
6. Substances occurring in mixtures
Standards to protect benthic (sediment dwelling) species

- Consistent with REACH with additional consideration of field data

- Sediment toxicity
  - Normalization to 5% organic carbon
  - Assessment factor (AF)

- Equilibrium partitioning
  - Experimental $K_{OC}$ preferred (OECD 106)
  - Or $K_{OC}$ derived from $K_{OW}$

- Field data
  - Possible sources: TEL, ERL, SLC, field based SSD ...
  - AF adjustment
  - Supported by annex V “the standard thus derived should be compared with any evidence from field studies.”
Metals and the need to cope with bioavailability issues

- Many ligands may influence:
  - FeOOH, MnOOH, carbonates, organic carbon (OC),
  - Sulphides
- Test design / data requirements: sediment characterization, equilibration time …
- Eventually normalize to OC
- If needed account for background levels ⇒ added risk approach
  - Baseline / “pristine” areas
  - Analysis of deep layer of undisturbed bed sediments / dating by radio-isotopic techniques
  - Databases, e.g. FOREGS (http://www.gsf.fi/foregs/geochem)
  - Modeling
Standards to protect benthic species - implementation

- Tiered assessment framework
- Tier 1: total concentration against EQS
- Tier 2: either
  - “bioavailable” fraction: SPME, POM, vs EQS<sub>water</sub>, organism vs EQS<sub>biota</sub>
  - DGT, AVS … for metals
  - In situ bioassays
  - Benthos assessment
Sources of uncertainty

- Substances responsible for sediment ecosystems impairment
- Lack of data / toxicity tests
  - Old / not “supported” substances
  - Data quality issue
- $K_{OC} / K_{OW}$
- Ecosystem protection
  - Predictive ability
- Compliance checking
- Substances not toxic to benthos but prone to biomagnification / adverse effects at higher trophic positions
What’s the predictive ability of sediment EQS?

- Extent to which [standards] are predictive of presence or absence of toxicity
- Works in North America in the 90s:
  - Empirical guidelines tested on datasets matching chemicals and ecotoxicological data
  - Data selection
  - Good results, but …
- Saint Lawrence river
  - High incidence of false negatives / sulphur
  - Mercury

Desrosiers M. & al. (2010) Toxicity prediction using sediment quality guidelines and design of a Tier 1 risk assessment framework for dredged sediments: Dealing with confounding factors in practice Integ. Env. Assess. & Manag. 6(2) 225-239
Some challenges at regional / basin scales

- **What are the substances of concern? How can they be identified?**
  - Current EU process
  - What will be topical in 10 years?

- **How are they best monitored (which media)?**

- **Are generic EQS relevant locally?**
  - Lessons from the literature
    - Tissue residues + bioaccumulation
    - Species sensitivity distribution
    - Adjustment of exposure evaluation
  - Pros and cons of basin- or region-specific EQS
# Substances of concern

- Art. 16: priority related to risks
  - Hazard
  - Exposure
    - Use (emission)
    - Occurrence (measurements)
- EU prioritization
  - Uses (quantitative, regulatory)
  - PBT, endocrine disruptor
  - PEC/PNEC
  - Size and robustness of datasets

<table>
<thead>
<tr>
<th>#</th>
<th>CAS #</th>
<th>Substances</th>
<th>Lead</th>
<th>General including reason for including in list of 40, and extent of use</th>
<th>PET/endocrine disrupting/CMR/other properties</th>
<th>PEC/PNEC ratio or similar comparison</th>
<th>Size and robustness of toxicity dataset</th>
<th>Size and robustness of monitoring dataset</th>
</tr>
</thead>
</table>
| 334 | 42576-02-3 | Methyl 5-(2,4-dichlorophenoxy)-2-nitroaniline (Bifentra) RED | COM | Herbiocide – post-emergence.  
Dir 91/414 Annex I – buffer zones  
Mon-based prioritisation - Mod-based prior 1  
Use: Authorised in 16 MS.  
Production and sales? No info in dossier. JRC model: 1000 t/yr. (Marketted by Makhteshim Agan (UK) Limited) | Not investigated by EU PBT group.  
Did not fulfill PEC criterion for Substances of Potential Concern under OSPAR Convention.  
(Corr. Not POP)  
Herbiocide action: disrupts membranes, inhibits photosynthesis.  
Endocrine disruption? Not in EU working doc.  
K_{OW} = 500-23000,  
BCF (fish) = 1500  
Hydrolysis – slight at pH 7  
Photolysis readily. Not easily biodegradable. | >1 especially if consider peak PEC.  
Modeling PEC  
Water: PEC1=0.56 µg l^{-1}, PEC2=0.05 µg l^{-1}  
30% (no expo) = 0.65 µg l^{-1}  
max = 0.05 µg l^{-1}  
max = 4.2 µg l^{-1}  
PEC1=5000 µg kg^{-1}, PEC2 = 50 µg kg^{-1}  
30% (exposure) = 50 µg kg^{-1}, max = 10200 µg kg^{-1}  
Sediment  
PEC1=5000 µg kg^{-1}, PEC2 = 50 µg kg^{-1}  
30% (exposure) = 50 µg kg^{-1}, max = 10200 µg kg^{-1}  
Tentative AA- QS_{Sediment} = MAC_{x} = 0.0125 µg kg^{-1}  
QSI_{Sediment} (fresh and salt water) = 4.4 µg kg^{-1}  
QS_{Sediment,EC} (fresh and saltwater) = 12.2 µg kg^{-1}  
Existing DE Quality Criterion: 0.01 µg kg^{-1} | Ecotoxic data fair for freshwater, limited for marine and sediment.  
AF = 10 for AA-QS_{Sediment}  
AF = 100 for AA-QS_{Sediment,EC}  
Monitoring database contains data from 3 MS (DE, FR, IT)  
Quantified above DL in only 83 analyses of 22 164 for water.  
In sediment, 11 of 2088 analyses (1 MS) quantified |
What will be topical in 10 years or so?

- **Data needed for prioritization, either exposure or toxicity**
  - Monitoring programs should include prospective actions
  - Compounds detected are candidates for hazard assessment – who cares?
- **Research programs: need to link with uses of chemicals**
  - Pharmaceuticals: a relatively successful story
  - What next?
  - Science – policy interface?
- **Specimen banks**
Monitoring strategy: follow your thumb

- Compounds with a log $K_{OW}$
  - $> 5$ “should preferably be measured in sediments, or SPM”
  - $< 3$ “… preferably … in water”
  - Between 3 and 5, sediment or SPM are optional

- Biota: physico-chemical properties and metabolism

- Sampling strategy
  - Sediments:
    - “Net deposition areas with soft sediments” / “relatively high amount” of fraction $< 63 \mu m$
    - Trends: 1 out of 3 years, compliance checking 1/year (2008/105/EC)
    - Grabs or corers
  - SPM: ??
  - Biota:
    - Species: “where there is a variety of protection objectives, it is preferable to choose a species that can satisfy them all” perch, chub, zebra mussel …
    - 6 months to annual; trends $\Rightarrow$ 1 out of 3 to 6 years
    - Wild populations or caging

Guidance on chemical monitoring of sediment and biota under the WFD (draft 4, March 2010)
Site-specific EQS derivation: biota / water

- Relationships between water and tissue concentrations depend on local conditions
- Translation of a generic tissue residue criterion to site-specific water
- Bayesian Monte-Carlo analysis used to derive a model linking water and tissue concentrations and predict the probability of exceeding the tissue criterion as a function of water conc.
- Sensitive to the amount of site-specific data available


- Applicability to sediment?
Adjustment according to bioavailability (metals, water)

• EQS derivation ↔ compliance checking (steps 1-2):
  – Option1 = no relationship between pH, hardness, etc. ⇒ QS generic,
  – Option2 = bioavailability correction – BioF factor applied to monitoring data, compared to reference QS
  – Option3: bioavailability correction applied to QS – site specific QS

• Last step: total versus added risk approach
• Less applicable to sediments (knowledge gaps, model development, controversies on the role of ligands)
Site-specific EQS derivation: sediment

- Hong-Kong coastal area (1651 km²)
- Benthic community survey (120 sites) and sediment quality monitoring (46 sites) databases
- Abundance decrease of 50% for sensitive species (AD50)
- Input AD50s in a bootstrap regression procedure ⇒ species sensitivity distributions
- HC5 < “imported” criteria

Pros and cons of site-, or regional-specific EQS

- Take account of background conc. and other ecological features
- Adapted monitoring strategies
- Stakeholders needs / transboundary hydro-systems

- Local authorities could set either
  - overly lax standards
  - overly stringent standards
- Consistency
  - among Member States?
  - in transboundary water bodies?

Ways forward

• Monitoring programs should include measurement of non priority compounds
• Hazard assessment of the compounds detected?
• Develop specimen banks
• Sediment and/or biota
  – Sediments are challenging, uncertain …: use with caution
  – Monitoring of biota could be developed
  – As well as the relationships between these media
• Science policy interface
  – Knowledge of the system (characteristics, background)
  – Research on data processing (normalization, trend analysis …)
  – Predictive ability of EQS
  – Basin-specific EQS or adjustment to bioavailability
Thanks for attention!

After-sales services: marc.babut@cemagref.fr