Establishing Environmental Groundwater Quality Standards

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Outline of the Presentation

- BRIDGE – The Project (FP6 – policy support)
- Methodology Framework (Concepts)
- Specific Results (practicalities)
  - Determination of Natural Background Levels (NBL)
  - Ecosystem Receptors
  - Groundwater as Receptor
MAIN OBJECTIVES

- Status Assessment
  - Large scale issues across GW-bodies
  - Threshold Values
- Prevent or Limit
  - Protecting quality at local scale (!)
  - Generic Standards (‘Regulatory Value’; Limit Values)
- Trend Assessment

STATUS ASSESSMENT (GW-BODY) & PROTECTION OF QUALITY

GOOD STATUS
Threshold Values
GW-Body specific

Receptors: Aquatic and terrestrial ecosystems? Links with SW status and EQS

Trend identification and reversal

Local Controls

Prevent / Limit

Generic Standards

Risks of pollution from diffuse/point sources (incl. landfills, wastes, contaminated soils, agriculture)

Run-off

Drinking water abstraction

Construct Products

Urban waste

Time
OBJECTIVES

European approach to derive *environmental thresholds* for groundwater bodies

- applicable at different levels (national, river basin or single groundwater bodies)
- reflecting multitude of possible pressures and variety of aquifer characteristics
- consistent to the WFD and other community legislation

- scientifically sound and practicable
Building a Common Approach
Underlying Concepts

- CONCEPTUAL MODEL
  - pressures, processes, pathways & receptors
- SIGNIFICANT IMPACT TO RECEPTOR
  - a risk-based approach
- RECEPTORS
  - Aquatic ecosystems
  - Dependent terrestrial ecosystems (GWDTE)
    - ‘groundwater’
- TIERED APPROACH
  - Linking thresholds and status assessment

Groundwater Quality & Status

**INDICATION FOR POOR STATUS**
- Polluted groundwater (significant impacts possible)
- Receptor-oriented standard
- Quality poor due to naturally elevated concentrations, but no human impact (chemical status: good)
- Variability in natural quality due to hydrochemistry
- Level of detection/quantification

**GOOD STATUS**
- Undisturbed groundwater
- Natural quality

**NATURAL QUALITY**

**ANTHROPOGENICALLY INFLUENCED**
- Alteration of groundwater quality

**INcreasing pollutant concentration**

**INcreasing concentration**
Tier 1
Initial Analysis

Tier 2
Detailed Analysis

Stage 2
[Impact Assessment]

Data requirements
work, costs

Conservatism

Uncertainty

Protection of
Environmental resources
**PROPOSED CRITERIA**

- Natural Background Level
- Reference Values (dependent on receptor choice)
- Dilution Factor (surface water)
- Attenuation Factor (surface water)

**Natural Background Levels**

*NBL’s might be derived on the basis of*

- GW-samples free of human impact
- Hydro-chemical simulation of solution processes
- *Pre-selection method (using indicators)*

- Component separation by concentration distribution analysis
Tiered approach to derive NBLs

European Aquifer Typologies for referencing NBLs

NBLs are different from one typology to the other

Further criteria:
- hydrodynamics (recharge, residence time, topography, leakage...)
- redox conditions
- particularities (organic matter, dykes...)
- geological age

Map (draft 2006): Research Centre Jülich
Austrian case study
NBL calculation & comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>NBL (BRIDGE) S. Vienna basin</th>
<th>NBL Geohint National</th>
<th>DWS / AA-EQS or national MPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium mg/l</td>
<td>123</td>
<td>133,6</td>
<td>n. a. / n. a.</td>
</tr>
<tr>
<td>Magnesium mg/l</td>
<td>39,4</td>
<td>40,8</td>
<td>n. a. / n. a.</td>
</tr>
<tr>
<td>Boron mg/l</td>
<td>0,041</td>
<td>0,04</td>
<td>1 / n. a.</td>
</tr>
<tr>
<td>Chloride mg/l</td>
<td>41,2</td>
<td>32</td>
<td>200 (Ind.) / n. a.</td>
</tr>
<tr>
<td>Sulfate mg/l</td>
<td>164</td>
<td>80</td>
<td>250 (Ind.) / n. a.</td>
</tr>
<tr>
<td>Phosphate mg/l</td>
<td>0,08</td>
<td>0,14</td>
<td>n. a. / n. a.</td>
</tr>
<tr>
<td>Chrome µg/l</td>
<td>0,9</td>
<td>4</td>
<td>50 / 8,5 (national MPA)</td>
</tr>
<tr>
<td>Arsenic µg/l</td>
<td>1</td>
<td>4</td>
<td>10 / 24 (national MPA)</td>
</tr>
<tr>
<td>Cadmium µg/l</td>
<td>0,16</td>
<td>0,2</td>
<td>5 / 0,08 – 0,25 (AA-EQS)</td>
</tr>
<tr>
<td>Nickel µg/l</td>
<td>1,9</td>
<td>4</td>
<td>20 / 20 (AA-EQS)</td>
</tr>
</tbody>
</table>

TIERED APPROACH
Aquatic Ecosystems

- matching risk characterisation for surface water vs. groundwater or
- other evidence for a substantial transfer of pollutants

Proposal EQS [COM(2006) 397 final!]

- AA-EQS (annual average)

  T4: Attenuation
  T3: Dilution
  T2: EQS
  T1: NBL
Receptor ‘surface water’

\[ c_g = \frac{c_r}{BFI} - \frac{c_s(1 - BFI)}{BFI} \]

- BFI = base flow index
- \( c_r \) = river background conc.
- \( c_s \) = river threshold
- \( c_g \) = groundwater threshold

**METHODS OF DETERMINING BASEFLOW**
- Age analysis, by assessment of hydrochemical mixing
- Tracer analysis, Temperature or Water Quality surveys
- Low flow assessment
- **Hydrograph separation**
- Numerical modelling of flows (deterministic or statistical)

**METHODS OF DETERMINING ATTENUATION**
- Comparison of monitoring results (GW & SW)
- Appropriate decaying transport models

⇒ **Choice of methods: Member States!**
**Area:**
~1046 km²  
68% Farmland  
16% Urban areas

**Population:**
- OPRB: 250,000
- ODENSE (City): ~200,000

**Figure:** Courtesy Fyns Amt (County of Fyn)

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**Cases study: Odense River Basin Conceptual model**

- **DRAINAGE SYSTEM**
- **SAND AQUIFERS**
- **CLAYEY TILLS**
Groundwater Threshold Value
According to the Aquatic ecosystem

N to be reduced by 67%
P by 50%

P to be reduced by 30%
P by 50%

Dilution/Attenuation for N: 1 / 0.5
Threshold Value: NO₃ < 20 mg/l (!)

Dependent Terrestrial Ecosystems

- lack of legal and scientific background
- general assumption: aquatic & terrestrial ecosystems (e.g. wetlands) need to adapt to similar conditions

Start procedure if
- monitored damages or

control other possible reasons
- exclude other possible impacts
- groundwater quantity
- pH, buffering effects, oxygen & nutrient concentrations

specific investigation by ecologists
Groundwater as a Receptor

- Groundwater should be protected in its own rights
- No agreed common understanding of the WFD and the GWD and the role of threshold values

**Possible Approaches**

- Groundwater as a resource (!)
  - Groundwater ‘itself’
  - (Groundwater as an ecosystem)

**Policy discussions/decisions:**

WFD Common Implementation Strategy: WG C

Groundwater ‘itself’

**Threshold at Tier 2**

- Background Values
  - Pragmatic adaptation at low natural concentrations
  - No ‘zero-pollution’-approach
  - Relating NBL to Reference-Values (e.g. Drinking Water Standards)
### Overview on receptor specific screening

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Criteria for GW Chemical Status</th>
<th>Reference Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water</td>
<td></td>
<td>AA-EQS</td>
</tr>
<tr>
<td>GWDTE</td>
<td></td>
<td>special regime</td>
</tr>
<tr>
<td>DWPA other uses</td>
<td>saline intrusion widespread pollutants significant impairment</td>
<td>NBL QS (see WFD) use related</td>
</tr>
<tr>
<td>Groundwater</td>
<td></td>
<td>NBL use related</td>
</tr>
</tbody>
</table>

### Characterisation process

**Understanding the system?**

- **GWD:**
  - single monitoring stations
  - GW-body (aggregated data)

#### Delineation of GW-bodies
- Extension across different aquifer types
- Representative for e.g.
  - recharge zone
  - aquifer storage
  - receptor

#### Problems, e.g.
- NBL derivation
- Depth variations
- Considering attenuation
**Environmental Threshold Values**

**PREREQUISITES (WFD & GWD):**
- may be GW-body specific (GWD)
  - even at the level of GW-bodies sensitive to delineation across aquifers with different hydrogeochemical characteristics (!)
- specific pollutants: see risk characterisation (Art. 5 reports!)
- receptor(s) need to be defined clearly!
  - Receptor ‘Groundwater’: management decision
  - **relevant TV**: according to sensitive receptor

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**THANK YOU FOR ATTENTION!**