Risk-based prioritisation of ground water threatening point sources at catchment and regional scale

Or: ”How to get an overview and remediate less”

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Outline

1. The challenge
2. The methods
3. The results

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The challenge

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The challenge

Danish EPA (2011)

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Danish EPA handbook, 2012
### Prioritisation principles

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditionally used parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Location within administrative areas</td>
<td>High priority to sites in areas with drinking water interests</td>
</tr>
<tr>
<td>Distance to extraction wells</td>
<td>High priority to sites close to extractions wells</td>
</tr>
<tr>
<td>Aquifer vulnerability</td>
<td>High priority in areas with thin or discontinuous clay layers and/or with a high net infiltration</td>
</tr>
<tr>
<td>Contaminant type</td>
<td>High priority to toxic/mobile contaminants</td>
</tr>
<tr>
<td>Contaminant concentration</td>
<td>High priority to sites with high concentrations</td>
</tr>
<tr>
<td><strong>Recently included parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Contaminant mass discharge</td>
<td>High priority to sites that cause a high contaminant load (kg/year)</td>
</tr>
<tr>
<td>Uncertainty of mass discharge estimate</td>
<td>Depends on strategy and overall workflow</td>
</tr>
</tbody>
</table>
Mass discharge and uncertainty estimates allow direct comparison

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Groundwater model or analytical calculation

Normalised mass discharge \( J_N \) (\( \text{m}^3/\text{year} \)) =

\[
\frac{\text{Mass discharge } J \ (\text{g/year})}{\text{Threshold conc. } C_{MCL} \ (\text{mg/l})}
\]

23 Main St. chlor.  11 North St. chlor.  Sum chlor.
17 East St. benzene  1 Industry Road benzene  Sum benzene
TCE meas. in extr. well  Threshold conc.
Case studies

• Greater Copenhagen

• Triangle area
Case study 1: Greater Copenhagen

Max. mass discharge
- > 100 g/yr.
- 10 – 100 g/yr.
- < 10 g/yr.
- None

Relative uncertainty
- Low
- Medium
- High

Brown rings: Net mass discharge considering pump-and-treat

Detailed analysis at 120 sites with chlorinated solvents
A closer look at Søborg Waterworks

- Maintain pump-and-treat!
- Site actions?
- Monitoring
- Identify unknown sources

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Cumulative impact on extraction

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Case 2: Triangle area

Potential threat to the ground water resource?

- Yes
  - Prioritisation of crucial sites
- No
  - Public efforts have been sufficient

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Case 2: Triangle area

Potential threat to the ground water resource?

Prioritisation of crucial sites

Public efforts have been sufficient

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Conc. in aquifer/threshold conc. [ ]

Impact on local aquifer

Impact on extraction wells

Conc. in extraction/threshold conc. [ ]

Potential critical sites

Region of Southern Denmark

With degradation, high GW recharge
Without degradation, high GW recharge
With degradation, low GW recharge
Without degradation, low GW recharge

Case 2: Triangle area
Conclusion

- Risk-based prioritisation is a tool for:
  - Overview
  - Targeting the right sites
  - Communication

Why is nothing being done at my Dad’s site?!
Thank you for your attention!
Perspectives and further development

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Thomsen et al. (2013)