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IBED

Adapting Chemical Risk Assessment for Water Systems in relation to Unconventional Hydrocarbons

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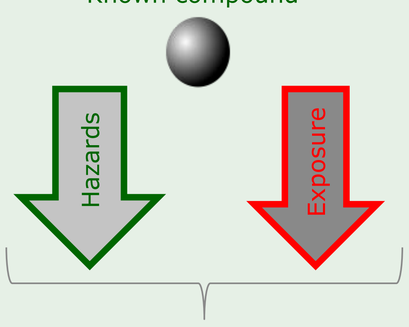
Background

Typical Chemical Risk Assessment (CRA)

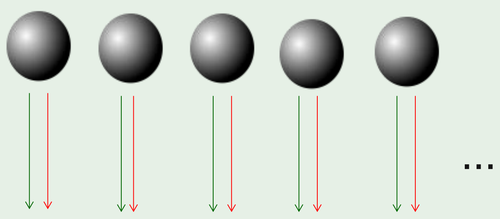
Known compound



Risk Characterisation (RC)

CRA for **unconventional** hydrocarbons

A large variety of compounds



Risk Characterisation more complex

Focus on EXPOSURE
(hazard remains unchanged)

Figure 1: Typical chemical risk assessment vs. risk assessment for unconventional hydrocarbons

Where and how to adapt chemical risk assessment for unconventional hydrocarbon activities?

Research Questions

1. How to assess the **different water types** and the **large number of chemicals?**
2. How applicable are available models for **environmental fate modelling**?
3. How applicable are current **water quality monitoring methods** to unconventional drillings?

Discussion & Conclusion

1. Currently only **45%** of suspect list compounds are **regulated under REACH**.
2. There is a need (1) for more research into **chemical fate under downhole conditions**, and (2) for **relevant exposure routes** to be integrated into the environmental fate models.
3. Current **water quality monitoring** is **insufficient** for risk assessment of unconventional drillings. Deep underground monitoring may be developed (1) **via technology** to increase accessability, and (2) **via legislation**.

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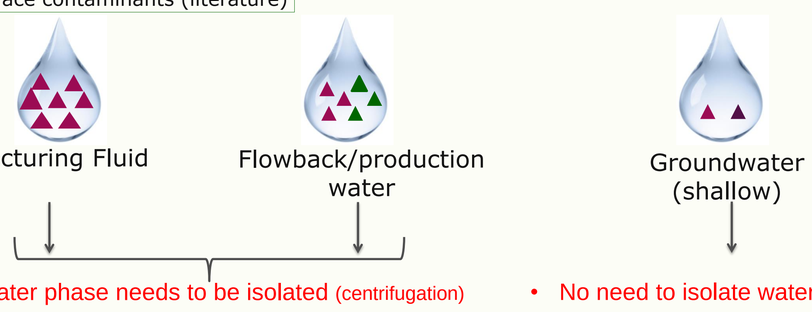
1 Chemical analysis of unconventional hydrocarbon related water

Broad screening with HPLC …

▲ Chemical additives (Fracfocus)
▲ Subsurface contaminants (literature)



- Water phase needs to be isolated (centrifugation)
- Direct injection possible
- No need to isolate water phase
- Need for concentration (SPE)

Figure 2: Differences in sample preparation between different water types due to differences in composition/concentrations

… using a SUSPECT LIST including …

Chemical additives and **Subsurface contaminants**

- Fracfocus database
- NAM database
- Literature: Orem et al. 2014, Hayes 2009, Olsson et al. 2013, etc.)

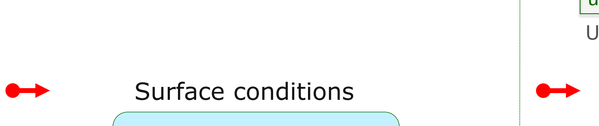


Figure 3: Compounds from suspect list regulated under REACH

Only **45%** of compounds included in the suspect list are regulated under REACH

Sjerps et al. 2016

Ongoing research: **Chemical** and **biological** analysis of **polar organic compounds** analysed in hydraulic stimulated gas well related waters, at KWR. Kolkman et al. 2013

2 Conceptual Box Models (QWASI; SIMPLEBOX, etc.)

Mackay et al. 2014; Hollander et al. 2016

Chemical fate information – **EPI Suite**: experimental vs. estimated values
- The reactivity of persistent organic pollutants is overestimated (Gouin et al. 2004)

Toxicological information – **TOXNET**
- Information not available for all compounds

Current conceptual box models are based on …

→ Surface/shallow exposure routes

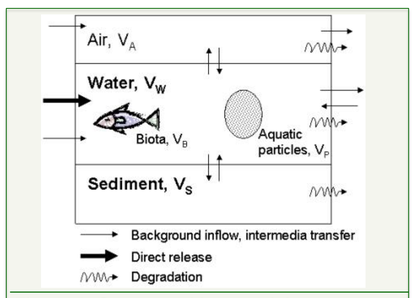


Figure 4: Conceptual box model exposures (socopse 2016 – example QWASI model)

→ Surface conditions

Pressure : **101325 Pa**
Temperature : **27°C**

Models for unconventional hydrocarbon activities need to consider …

→ More complex exposure routes

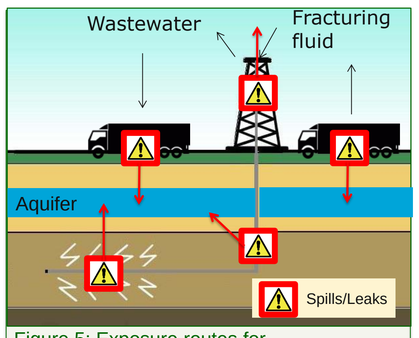


Figure 5: Exposure routes for unconventional hydrocarbon activities

U.S. EPA 2015

→ Downhole conditions

Pressure : ≈**25 GPa**
Temperature : ≈ **100°C**

Increased T and P may affect chemical fate parameters Kahrilas et al. 2014

3 Water Quality monitoring

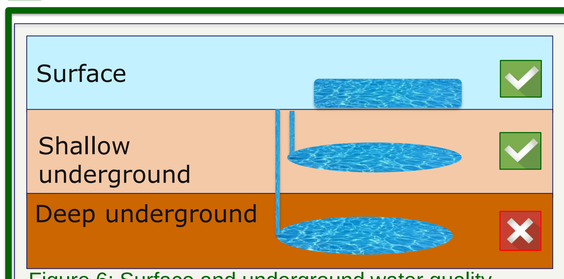


Figure 6: Surface and underground water quality monitoring

Shallow underground ≈ **first 100 meters**
vs
Hydraulic fracturing depth ≈ **4000 m**

Deep underground
limited/no monitoring:
- difficult to access
- failures and their probabilities are not known

European Commission 2015

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Research topic: Chemical risk assessment of hydraulic fracturing for shale on water systems, in the Netherlands (2015-2019).