

Comment on the German Draft Legislation on Hydraulic Fracturing: The Need for an Accurate State of Knowledge and for Independent Scientific Research

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Exploitation of unconventional gas resources is challenged by societal concerns about environmental risks associated with high volume multistage hydraulic fracturing (HF) in horizontal wells.¹ To regulate HF in Germany, on April first 2015, the German Chancellor's cabinet signed off on a draft law which is currently under discussion in the parliament and states the following (Figure 1):

- (1) HF is prohibited in water protection areas, their catchments and natural habitats by the Water Management Act and the Federal Nature Conservation Act

(WHG §13a, Para.1 No. 2, BNatSchG §23 Para. 3, §24 Para. 3, §33 Para.1a). Not regulated are catchments of deeper groundwater horizons or abstraction areas for beverage industries (WHG §9, Para. 2).

- (2) Elsewhere, HF and disposal injections of formation water are possible, but subject to Environmental Risk Assessment by Mining Authorities (WHG §9, Para. 2) involving declaration of all chemical additives (WHG § 13b Para. 1).
- (3) In shale, coal, clay and marl formations less than 3000 m deep, HF activities are forbidden except for (i) scientific investigations to explore environmental impacts of HF, or (ii) if an accompanying scientific expert panel concludes that HF for commercial purposes is nonproblematic in a given formation (WHG §13a Para. 2, 6, 7).

As expert group on HF chemicals within the Water Chemistry Society, German Chemical Society (GDCh) we appreciate the intention to put the topic in Germany on a well-founded regulated basis. Together with scientists from North America we nonetheless comment on the draft—guided by current scientific knowledge, research gaps, and the necessity of independent research.

■ THE NEED FOR AN ACCURATE STATE OF SCIENTIFIC KNOWLEDGE

We are surprised that the draft does not adequately differentiate between “conventional fracking” in vertical wells with small fluid and chemical volumes versus more recent **multistage hydraulic fracturing in long horizontal wells** with large volumes. Instead,

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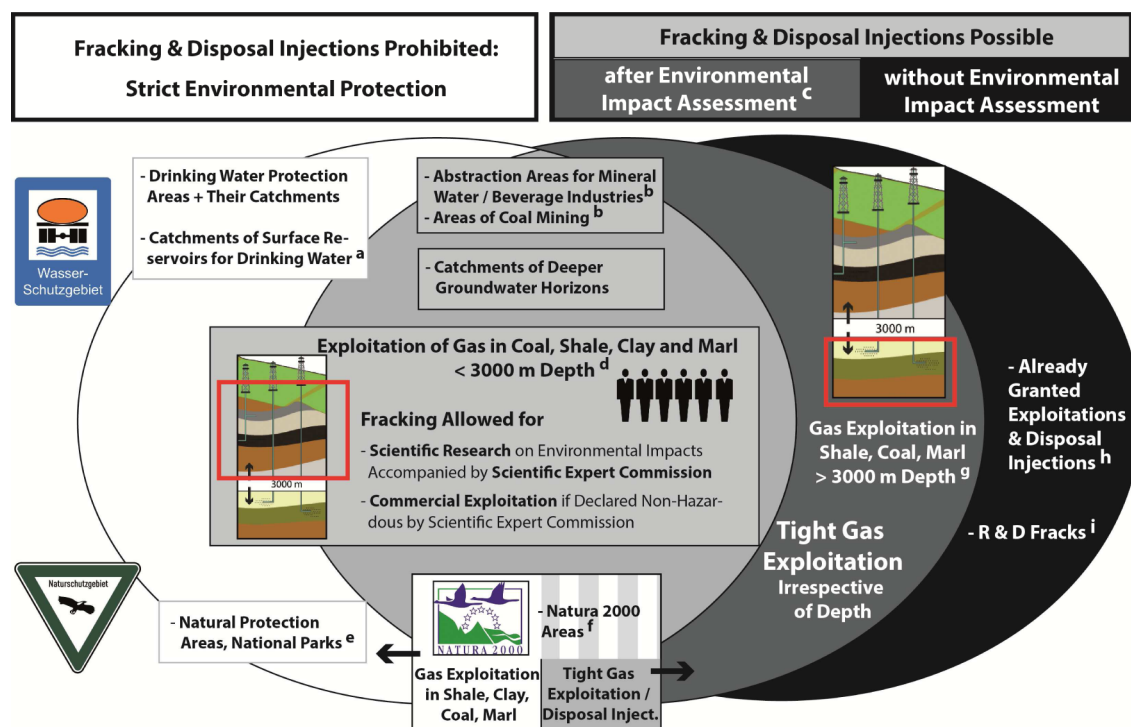


Figure 1. Schematic representation of the current German draft legislation on HF. (a) Water Management Act (WHG) §13a, Para.1 No. 2. (b) left to state legislation. (c) WHG §9, Para.2, Environmental Risk Assessment of Mining Authorities (WUVV-Bergbau) §1 No. 2. (d) WHG §13a Para.2, 6, 7. (e) Federal Nature Conservation Act (BNatSchG) §23 Para.3, §24 Para.3, §33 Para.1a. (f) BNatSchG §7 Para.1 No. 8. (g) WHG § 13a Para.1. (h) Over a period of five years, UVP-V Bergbau §4 Para.5; ¹ UVP-V Bergbau §1 No. 2.

exemptions are made for **tight gas exploitation** (see Figure 1). In North America gas and oil production from tight sands and shales proceeds almost exclusively via multistage hydraulic fracturing in horizontal wells which may exceed 2 km in length. Types and volumes of fracturing fluids and chemical additives on local geology. We believe that risks to shallow water resources more likely depend on the type of drilling, hydraulic fracturing and well integrity than on the type of the reservoir and suggest this should be reflected in the draft.

■ THE NEED TO RECOGNIZE SCIENTIFIC RESEARCH GAPS

Wastewater comprises both flowback (the fracturing fluid reemerging after HF) and formation water (the emerging geogenic fluid). The draft suggests to separate both (ABergV §22c Para.2), treat flowback aboveground and deal with formation water by disposal injections. We stress that flowback and formation water emerge largely as mixtures and cannot be separated. Further, **the chemicals present in flowback and formation water are far from being fully characterized and understood.**² Even if HF additives were fully declared, additional research is needed to characterize subsurface transformation products, geogenic substances, and their overall toxicity which all are site-specific. Also, **established aboveground treatment solutions for flowback water do not always exist**, especially not when flowback is inevitably mixed with highly saline formation waters. Complex organic and inorganic chemicals (in some cases even radioactive) are found in the U.S. where shale gas has been explored for more than one decade.³ **The perception that Environmental Impact Assessments for disposal injections can pillar on the knowledge of all chemicals (WHG §13b Para. 1, UVPV-Bergbau §2 Para. One No. 3) is, therefore, not realistic.** Finally, long-term effects of

such injections (both regarding water quality and seismicity) warrant systematic research. To our knowledge monitoring of water quality in the vicinity of deep disposal wells has hardly occurred, neither in Germany nor in North America.

■ THE NEED FOR FURTHER REGULATIONS TO ENSURE MEANINGFUL AND INDEPENDENT SCIENCE

(a) We welcome the disclosure of all chemicals, yet recommend that **additional regulations (on chemicals' cadasters) must ensure the distinct assignment of a substance's identity** demanding not only the CAS RN but also the IUPAC name, which is essential for research on water quality. Further, toxicity assessments of chemicals according to Water Hazard Classes (VwVwS) need to be harmonized with the EU "Regulation on Classification, Labelling and Packaging of Substance and Mixtures" so that hazards to water resources are considered instead of hazards during industrial handling. (b) Additional regulations by the Federal Ministry of Education and Research must ensure that (i) **investigations are conducted by independent scientists rather than industry**; (ii) **appropriate funding schemes guarantee scientific independence**; (iii) a **peer reviewed application system** applying highest standards is based on scientific excellence, defines best-practice monitoring and prevents explorations that do not clearly advance insight into environmental impacts. **Existing information should be made accessible whenever possible.** Presently, already granted activities are exempted from Environmental Impact Assessments (WHG §9, Para. 2) and the draft does not consider research and monitoring of these operations.

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Notes

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■ REFERENCES

- (1) Vengosh, A.; Jackson, R. B.; Warner, N.; Darrah, T. H.; Kondash, A. A critical review of the risks to water resources from unconventional shale gas development and hydraulic fracturing in the United States. *Environ. Sci. Technol.* **2014**, *48* (15), 8334–8348.
- (2) Arnaud, C. H. Figuring our fracking wastewater. *Chem. Eng. News* **2015**, *93* (11), 8–12.
- (3) Gregory, K. B.; Vidic, R. D.; Dzombak, D. A. Water management challenges associated with the production of shale gas by hydraulic fracturing. *Elements* **2011**, *7* (3), 181–186.