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Assessing unconventional natural gas development: Understanding risks in the context of the EU

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Abstract

Unconventional natural gas development (UNGD, e.g. shale gas) poses a threat to the environment and human health. While the Member States of the European Union (EU) decide whether to develop this resource, they require evidence to assess the associated risks. Much of the evidence regarding the risks (e.g. contamination, exposure, disturbance) comes from the US, and we argue this evidence cannot be used by the Member States to conduct risk assessments due to demographic differences, geological differences, and differences in regulation. The EU, as a whole, has recognized their need for evidence and has funded research partnerships to explore the environmental effects of UNGD. We argue that such research efforts need to be extended further in order to address the gaps in human health studies and to develop comprehensive environmental baseline studies.

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Keywords

Shale Gas, fracking, environmental risks, unconventional natural gas, health risks.

Introduction to the problem

The development of unconventional fossil fuels could transform the energy landscape in Europe. The European Commission's Joint Research Centre estimates the technically recoverable potential of unconventional natural gas (UNG) to be approximately 16 trillion cubic meters [1]. The exploitation of UNG has been made possible by two engineering advancements: horizontal drilling and high-volume hydraulic fracturing (HVHF). Of these techniques, HVHF has caused considerable public concern because of the risks it poses to the environment and human health, e.g. the release of fugitive methane emissions, contamination of surface and groundwater sources, induced seismicity, and noise [2,3]. Because the risks to the European community are uncertain, decision makers from different Member States have hesitated over the decision to exploit UNG reserves [4,5]. This has led to different approaches to exploiting these resources within the EU: countries such as France and Bulgaria have banned HVHF altogether, whereas others such as Poland and the United Kingdom have granted permission to drill and hydraulically fracture test sites. It is not likely that one unified approach to UNG development and regulation will be adopted. As Member States move towards making final decisions about UNG development, they will need sound scientific evidence about the risks and benefits of development to inform their risk assessments and environmental policies.

Such evidence about risks and benefits tends to be gathered from sites located in the US, largely because this is where the shale gas revolution began in 2008 [6]. In this paper, we argue that the evidence from the US is site-specific and should not form the basis for Member State policies and risk assessments [7]. In Section 1, we summarize the recent peer-reviewed evidence about environmental and human health risks associated with UNGD, which is mostly US-driven. Then, in Section 2, we critically review the relevance and limitations of this evidence with respect to supporting risk assessments in the EU. In Section 3, we review the current and ongoing UNG research activities in the EU.

Summary of current research

In this paper, we focus on risks related to the environment and human health. In Table 1 we have identified some recent empirical research on these risks. This list is not comprehensive; it is meant to highlight recent relevant studies on UNG that have been conducted in the US and are relevant to human health risks and the environment.

Limitations of current research for EU policy

Below, we discuss three ways in which the current evidence about environmental and human health risks linked to UNGD does not generalize to specific Member State settings. For example, studies about the environment and human health largely emerge from the Marcellus shale (Appalachian Basin), one of the five largest shale plays in the US [27]. Moreover, these studies have often focused on Pennsylvania, a region with a rich history of conventional oil and gas development, coal mining, and heavy industry [35].

Table 1

Summary of evidence to support environment and human health risk assessments.

	Specific issues	Relevant evidence
Human health effects	Noise from HVHF activities (e.g. drilling, compressors, heavy vehicle traffic)	8–10
	Health effects due to chemical exposure (e.g. air emissions, contaminated water)	11–16
Environmental contamination and disturbances	Wastewater treatment and disposal of HVHF flowback and produced water	17,18
	Water quality of surface water and shallow aquifers	18–21
	Spills and above ground accidents affecting surface waters and soils	22–24
	Emissions such as methane, and CO_2 and CO from heavy vehicles	25

Subsequently, we contend that policymakers should be careful in their use of these studies to inform policy.

Link to human health exposure

To date, few studies investigate the impacts of HVHF on human health. These studies have identified an association between UNGD and negative human health effects, but have not been able to establish causality. Though these studies might assist Member State decision-makers in arguing that UNG poses health risks, they have not firmly established causality, nor can they narrow down the source of health effects to UNG exposure alone.

For instance, using household proximity to natural gas wells as a surrogate for exposure to UNGD hazards, researchers have found an association between proximity and prevalence of dermal and respiratory conditions [15], and sinus, migraine headaches, and fatigue symptoms [11]. Similarly, others have found an association between residential proximity to natural gas wells and an increased risk in asthma exacerbations [13], increased inpatient prevalence [14], and prevalence of congenital heart defects in infants [16]. Findings from these studies fall short of establishing a causal link between the hazards of UNGD and health effects for a number of reasons. First, studies that use residential proximity as a surrogate for exposure cannot confirm that exposure has occurred, nor account for the level or duration of exposure. Second, methods that use self-reporting can be limited by awareness bias; being made aware of a possible association with health issues increases the likelihood of reporting adverse health conditions [15]. Third, as a surrogate for exposure, proximity aggregates all environmental exposures into a single measure, which makes it impossible to determine whether the hazard is responsible for eliciting the health effect.

Biomonitoring studies can overcome these issues. Caron-Beaudoin and colleagues (2018) evaluated the effects of exposure to VOC emissions from UNGD operations on pregnant women [28]. The results showed that there were elevated levels of VOC metabolites in participants' urine, compared to the general Canadian population. The narrow scope of this study — a specific hazard - enables researchers to more closely understand the effects that an environmental hazard has on a receptor. Further biomonitoring studies conducted in the EU can enable Member State decision makes to assess and verify the risks of UNGD to human health.

Context dependent evidence – Pennsylvania ≠ Poland

That Pennsylvania is not Poland goes without saying. Each region has a unique geology, demography, and socio-economic character, and these differences mean that evidence generated to assess risks in the US cannot be generalized to Member State risk assessments [29].

Take, for example, studies on water quality in shallow aquifers in the Marcellus shale. The potential for HVHF to stimulate unintended transmission of brine, methane, and chemical contaminants has been raised [30], yet recent work has found that the water quality of shallow aquifers might not be affected by UNG activities [31]. Further, water quality near unconventional wells remains similar to historic levels [32]. That being said, in one study nearly all analyzed samples in the Marcellus region failed on at least one water quality metric, and the cause of these failures were uncertain [33]. Aquifer water quality is site specific: a function of, for example, geology, aquifer depletion, agricultural activity [34]. In order to assess change (and quantify risks) due to UNGD, Member State policy makers require baseline studies of aquifers and surface waters, as well as a robust monitoring program.

The differences in population density also make it difficult to generalize results from the US to the EU. Projected regions for UNGD in the EU are more densely populated than corresponding US regions [35], and this increase in population density will amplify the risk posed by hazards such as noise. Noise is a biological stressor known to cause annoyance, sleep disturbance, cardiovascular health problems [10], and is therefore of increasing regulatory concern in the EU [36]. Noise is generated from UNG activities, due to drilling and heavy equipment, and is not limited to well-pads. Populations some distance beyond the well-pad setback also tend to be affected (due to roadways, pipelines, and compressors) [8,9].

US study sample demographics also make it difficult to generalize study results to the EU and Member States.