

# State of Knowledge of the Links between Shale Gas Activities and Public Health

**UPDATE**

Environmental Health and  
Toxicology Branch

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## EXECUTIVE SUMMARY

In 2010, the Institut national de santé publique du Québec (INSPQ) published a literature review documenting the links between shale gas activities and public health (Brisson et al., 2010). This document is an update to that report. The update was motivated by a number of events, including a strategic environmental assessment (SEA) commissioned by the Quebec government<sup>1</sup>, the announcement of oil exploration projects in Quebec using similar techniques, new gas-industry-related incidents in the United States and Quebec and the ongoing publication of scientific data on the topic. This update highlights the new knowledge published since 2010 on the health issues related to the shale gas industry and identifies gaps in the scientific knowledge with respect to various human risk factors. The themes addressed in this document are the same as in the 2010 report.

Several scientific working groups within the INSPQ's Environment and Health Unit have contributed to this review, which is based on systematic literature review approaches. Specific key words were used to consult a number of documentary databases and query various search engines. The titles and documents identified were subsequently evaluated in terms of their relevance and scientific quality, and the selected papers were subjected to a critical synthesis.

### **Update of knowledge on health risks**

The results of the literature review are presented by theme: technological risks, air pollution risks, water contamination risks, and quality-of-life risks.

#### *Technological risks*

The review of the literature since 2010 showed that there has not been a great deal of new scientific data on the human health impacts of shale gas exploration and production. Eighteen studies dealing with this theme were selected for the update, with the following findings:

- Explosions, fires, leaks and spills of hazardous materials are the types of incidents in the United States and Canada likely to pose a threat to population health. In terms of scope, for example, a survey in the United States identified over 825 different environmental incidents.
- Most of the accidents during the gas exploration and production process stem from human error, negligence, equipment failure and the inadequate completion of gas wells.
- In the event of chemical spills and leaks, the neighbouring population, workers and first responders are the people at the most risk of serious harm.
- Transporting hazardous materials involves specific risks during the various phases of transportation.

The papers surveyed also provided findings on how to manage these risks:

- Industry monitoring and tightened legislation seem to be effective measures for reducing the frequency of environmental events.

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<sup>1</sup> The SEA reports on shale gas development commissioned by the Quebec government are accessible online: <http://www.mddelcc.gouv.qc.ca/evaluations/Gaz-de-schiste/index.htm>

- Emergency measures and monitoring are still aspects of risk management that merit careful consideration, one of the challenges being to develop cooperation between the gas industry and the key public bodies concerned.

Furthermore, the findings in the literature show that knowledge about the nature and quantity of the chemicals used in the gas industry and their handling and transport is still incomplete. Because of this lack of knowledge, it is not yet possible to assess the potential level of exposure of workers and the surrounding population to these chemicals or to evaluate the risks involved.

#### *Risks related to air pollution*

Exposure to air pollutants is associated with a number of health impacts, including cardiorespiratory effects. The update on the health risks associated with air pollution is based on 14 new papers. The following findings were drawn from these papers:

- Modelling and measurements done since 2010 in the vicinity of shale gas sites indicate local increases in the concentrations of some air pollutants, specifically concentrations of fine particles and ozone and its precursors (i.e., VOCs).
- Very few studies have focused on the health risks related to the exposure to air pollutants emitted during shale gas exploration and production. According to some assessments, the risk is higher for individuals living in the vicinity of wells (e.g., < 1 km) or in counties in the United States with a higher concentration of shale gas activity.

From a risk management perspective, the collected scientific literature and best practices related to health risk assessment suggest the use of health risk estimation approaches, including for the cumulative effect of chemicals emitted into the air and air pollutant measurements, prior to any exploratory activity. Moreover, the risk management principles applied to public health (Ricard, 2003) seem to indicate that risk would be better managed by taking into account separation distances between shale gas exploration and production sites and inhabited areas.

Lastly, the findings in the literature indicate that the indirect health effects of greenhouse gas emissions from shale gas exploration and production must be taken into consideration for the consistent documentation of risks based on public health practices.

#### *Risks related to water contamination*

Eighteen new papers were selected to complete this update and pinpoint the nature of the potential risks for groundwater contamination. For example:

- Cases of contamination are known to have occurred after accidents, for example, as a result of a technical failure during fracturing with the release of brine, sludge and fracturing products into the environment or related to a gas leak due to a breakdown in the extraction infrastructure, or during regular shale gas extraction operations.
- It was shown that gas wells with compromised tightness and structural integrity were behind cases of contamination under normal operating conditions.
- A controversial hypothesis suggests that contaminants in the bedrock migrate more rapidly to the surface through cracks or fissures caused or stimulated by hydraulic fracturing. This hypothesis needs to be supported through new research. If it is confirmed, the risk of water table contamination would persist even if definitive technical solutions were developed for the leakage issues.

Lastly, as in the INSPQ's 2010 review (Brisson et al., 2010), this literature review showed that there are still areas where knowledge needs to be acquired.

### *Risks related to quality of life*

The update to the literature on the impacts on quality of life and on psychological and social dimensions identified 22 new papers. The new papers confirmed the results presented in 2010 (Brisson *et al.*, 2010). Shale gas exploration and production activity is likely to have impacts on the quality of life and on social and psychological health, including the following:

- The increased traffic, noise, bright lights and vibrations caused by these industrial activities are disruptive to the neighbouring population, particularly to people living in the vicinity of a drilling site or a road used by workers.
- The “boomtown” phenomenon has been observed over and over again in U.S. American communities with shale gas development. When the “boomtown” phenomenon is present, socioeconomic, cultural and psychological impacts result. These impacts vary based on the profile of the host community, the infrastructure and services available and the level of preparedness of the authorities.
- Housing shortages, increased prices for goods and services, and growing tension and conflict were noted in several of the cases studied.
- In turn, the nuisance factors and social impacts have caused some people to experience stress, anxiety, anguish and feelings of loss of trust and control.

Standard impact assessment practices indicate that each population should be investigated and characterized before the industry moves in order to better prevent some of the social and psychological impacts.

### **Perspectives on risk management**

The risk management perspective advocated by the Quebec public health system recommends guiding principles for cases of this kind, including transparency, participation, equity, empowerment, prudence and scientific rigour. Scientific progress has been made, and continues to be made, in order to identify problems and assess solutions to reduce the health impacts of this industry. However, new scientific questions have been raised about several risk factors whose long-term impact on health remains a concern for communities where gas development is taking place.

Furthermore, the results of this literature review demonstrate the importance of pursuing research in order to guide the stakeholders concerned in their approach to shale gas exploration and production in Quebec. The findings also confirm the key risk management parameters that contribute to informed decision making. Some of the important steps involved are:

- Monitor the developments in scientific research;
- Document and make available the data on exposure to various risk factors;
- Document and measure the parameters present prior to any activity; and
- Establish prevention and protection measures to mitigate health risks.

## CONCLUSION

Taking an interest in shale gas activity is consistent with Quebec's public health mandate, which is focused on protecting and improving population health and well-being. Shale gas exploration and production have raised, and continue to raise, scientific, technical, social and political concerns and debate in the province, in particular issues of concern regarding possible human health risks. The INSPQ's 2010 literature review (Brisson et al., 2010), like this update, is therefore in keeping with a global health perspective, which is understood to be more than simply the absence of disease, but also an opportunity to maintain and develop all the dimensions of individual and collective well-being. The INSPQ has therefore tried to address the various dimensions in this document.

The purpose of the review was to identify and analyze the scientific literature published since the 2010 state of knowledge report on the risk factors that could have an impact on human health in connection with shale gas exploration and production (accidents, air and water contamination, social and quality-of-life impacts). The work is based on a rigorous methodology, similar to the systematic literature review approach, where the relevance and quality of the papers are examined prior to critical analysis.

The results of the update provided evidence-based data that confirm the hypotheses made in 2010. None of the update results minimized or invalidated the results of the first literature review (INSPQ, 2010). However, there is still some uncertainty in the scientific knowledge about the links between shale gas and public health.

For each of the themes examined, new findings and areas for future research were identified.

### Technological risks

The review of the recent literature reveals that there has not been a lot of new scientific data on the impact of shale gas exploration and production on human health. Eighteen papers were identified for this update, with the following conclusions being drawn:

- Explosions, fires, leaks and spills of hazardous materials are the types of incidents in the United States and Canada likely to pose a threat to population health. In terms of scope, for example, a survey in the United States identified over 825 different environmental incidents.
- Most of the accidents during the gas exploration and production process stem from human error, negligence, equipment failure and the inadequate completion of gas wells.
- In the event of chemical spills and leaks, the neighbouring population, workers and first responders are at the most risk of serious harm.
- Transporting hazardous materials involves specific risks during the various phases of transport.
- The papers surveyed also provided findings on how to manage these risks.
- Elsewhere in the world, industry monitoring and tighter legislation are advocated as effective measures for reducing the frequency of environmental events.
- Emergency measures and monitoring are aspects of risk management that merit careful consideration, one of the challenges being to develop cooperation between the gas industry and the key public bodies concerned.

The findings in the literature show that knowledge about the nature and quantity of the chemicals used in the gas industry and their handling and transport is still incomplete. Because of this lack of knowledge, it is not yet possible to assess the potential level of exposure of workers and the surrounding population to these chemicals or to evaluate the risks involved.

### **Air pollution**

Exposure to air pollutants is associated with a number of health impacts, including cardiorespiratory effects. The update on the health risks associated with air pollution is based on 14 new papers. According to this literature review, local increases in the levels of some air pollutants, particularly fine particles and ozone and its precursors (i.e., VOCs), can be expected in the vicinity of shale gas exploration and production sites, based on the modelling and measurements done since 2010. Very few studies have focused on the health risks associated with exposure to air pollutants emitted during shale gas exploration and production. According to some assessments, the risk is higher for individuals living in the vicinity of wells (e.g., < 1 km) or in counties in the United States with higher concentrations of shale gas activity.

From a risk management perspective, the collected scientific literature and best practices related to health risk assessment suggest the use of health risk estimation approaches, including for the cumulative effect of chemicals emitted into the air and air pollutant measurements, prior to any exploratory activity. Moreover, the risk management principles applied to public health (Ricard, 2003) seem to indicate that risk would be better managed by taking into account separation distances between shale gas exploration and production sites and inhabited areas.

Lastly, the findings in the literature indicate that the indirect health effects of greenhouse gas emissions from shale gas exploration and production must be taken into consideration for the consistent documentation of risks based on public health practices

### **Water contamination**

Eighteen new papers were selected for this update and indicate that there is real potential for groundwater contamination. Of particular note:

- Cases of contamination are known to have occurred after an accident, for example, as a result of a technical failure during fracturing with the release of sludge and fracturing products into the environment or during a gas leak due to a breakdown in the extraction infrastructure, or during regular shale gas extraction operations.
- It was shown that problems with gas wells with compromised tightness and structural integrity were behind cases of contamination under normal operating conditions.
- A controversial hypothesis suggests that contaminants in the bedrock migrate more rapidly to the surface through cracks or fissures caused or aggravated by hydraulic fracturing. This hypothesis remains to be proven or disproven by new research. If it were to be confirmed, the risk of water table contamination would persist even if definitive technical solutions were developed for the leakage problems.

Lastly, as in the INSPQ's 2010 review (Brisson et al., 2010), this literature review showed that there are still areas where knowledge needs to be acquired.

## **Quality of life**

The update to the literature on the impacts on quality of life and on psychological and social dimensions identified 22 new papers. The new papers confirmed the results presented in 2010 (Brisson et al., 2010). Shale gas exploration and production activity is likely to have impacts on the quality of life and on social and psychological health, including the following:

- The increased traffic, noise, bright lights and vibrations caused by to these industrial activities are disruptive to the neighbouring population, particularly to people living in the vicinity of a drilling site or a road used by workers.
- The “boomtown” phenomenon has been observed over and over again in U.S. American communities with shale gas development. When the “boomtown phenomenon” is present, socioeconomic, cultural and psychological impacts result. These impacts vary based on the profile of the host community, the infrastructure and services available and the level of preparedness of the authorities.
- Housing shortages, increased prices for goods and services, and growing tension and conflict were noted in several of the cases studied.
- In turn, the nuisance factors and social impacts have caused some people to experience stress, anxiety, anguish and feelings of loss of trust and control.

Standard impact assessment practices indicate that each population should be investigated and characterized before the industry moves in order to better prevent some of the social and psychological impacts.

## **Perspectives on the health risks associated with shale gas exploration and production**

The risk management perspective advocated by the Quebec public health network recommends guiding principles for analysis and synthesis in cases of this kind. These principles include transparency, participation, equity, empowerment, prudence and scientific rigour (Ricard, 2003). According to the Quebec public health network, following these principles establishes a basis for optimal management of health risks.

The 2010 State of Knowledge (Brisson et al., 2010) raised a number of concerns with regard to health risks. This update shows that new scientific knowledge has made authorities aware of the need to document the risks associated with this industry in order to exercise better control and prevention. Advances have been made, and continue to be made, in this area in the United States. This work has identified problems for which solutions exists and can be implemented to reduce the impact, particularly in terms of accident risk management. However, new scientific questions have been raised with regard to several risk factors whose long-term impact on health remains a concern for communities where gas development is taking place, such as risk of groundwater contamination. The results of this new research have engaged the scientific community, and concerted efforts are being made, especially in the United States, to validate the hypotheses being raised. It is crucial to monitor these research developments so that Quebec is positioned to make informed decisions about shale gas exploration and production within its boundaries.

Furthermore, the results of the literature review demonstrate the importance of pursuing research in order to guide the stakeholders concerned in their approach to shale gas exploration

and production in Quebec. The review findings also confirm the key risk management parameters that contribute to informed decision making. Some of the important steps involved are

- Monitor the developments in scientific research;
- Document and make available the data on exposure to various risk factors (number of wells drilled annually, description of the communities, identification of vulnerable populations, etc.);
- Document and measure the parameters present prior to any activity; and
- Establish prevention and protection measures to mitigate health risks.