

FRACKING:

THE NEW GLOBAL WATER CRISIS



COVER: BOTTOM CENTER IMAGE BY IVAN DEMITROV; BOTTOM RIGHT IMAGE BY LAURIE BARR / COURTESY OF COMMONS.WIKIMEDIA.ORG

About Food & Water Watch

Food & Water Watch works to ensure the food, water and fish we consume is safe, accessible and sustainable. So we can all enjoy and trust in what we eat and drink, we help people take charge of where their food comes from, keep clean, affordable, public tap water flowing freely to our homes, protect the environmental quality of oceans, force government to do its job protecting citizens, and educate about the importance of keeping shared resources under public control.

Food & Water Watch

1616 P St. NW, Suite 300
Washington, DC 20036
tel: (202) 683-2500
fax: (202) 683-2501
info@fwwatch.org

California Office

25 Stillman Street, Suite 200
San Francisco, CA 94107
tel: (415) 293-9900
fax: (415) 293-8394
info-ca@fwwatch.org

www.foodandwaterwatch.org

Copyright © March 2012 by Food & Water Watch.

All rights reserved.

This report can be viewed or downloaded at
www.foodandwaterwatch.org.



FRACKING: THE NEW GLOBAL WATER CRISIS

Executive Summary.....	2
Introduction.....	3
History and the Next Wave of Fracking.....	3
The U.S. Experience: Adding Up the Risks and Costs.....	4
Fracking’s impact on public water resources	5
<i>Examples of water pollution in the United States from shale development</i>	<i>5</i>
<i>How shale development pollutes freshwater resources.....</i>	<i>6</i>
Air pollution from fracking.....	7
The U.S. Experience: Exaggerated Claims of Economic Benefits	9
Fracking Around the World.....	10
Mineral rights ownership.....	10
France.....	11
Bulgaria	11
Poland.....	11
South Africa.....	12
China.....	12
Argentina	13
Conclusion.....	13
Endnotes.....	14



PHOTO © JOSH LOPEZ / JOSHLOPEZPHOTO.COM

Executive Summary

Within the past decade, technological advances in horizontal drilling and hydraulic fracturing, or “fracking,” have enabled the oil and gas industry to extract large quantities of oil and natural gas from shale formations in the United States. However, the practice has proven controversial. Pollution from modern drilling and fracking has caused widespread environmental and public health problems and created serious, long-term risks to underground water resources.

In this report, Food & Water Watch reviews the risks and costs of shale development that have been demonstrated in the United States, including economic costs that run counter to industry-backed claims about the economic benefits of the practice.

Food & Water Watch then summarizes the state of shale development in six selected countries: France, Bulgaria, Poland, South Africa, China and Argentina.

Briefly:

- Strong public opposition to fracking in France and Bulgaria has led to national bans on the practice.

- The government of Poland has welcomed oil and gas industry plans to develop shale resources in the country, but charges of bribery during the process of awarding leases have tainted these plans.
- Pending an environmental review by the South African government, Royal Dutch Shell may soon be granted permission to drill and frack in South Africa’s Karoo Basin.
- The Chinese government is pushing an expansion of shale development, and numerous oil and gas companies are partnering with Chinese firms, both in the United States and in China.
- In Argentina, oil and gas companies have begun developing shale oil and shale gas resources in the Neuquén Basin, with the support of the Argentinean government.

Instead of exposing their citizens to the damages of modern drilling and fracking, countries around the world should enact national bans on the practice and invest aggressively in the deployment of energy efficiency and renewable energy technologies.



Source: U.S. Energy Information Administration, based on Advanced Resources International, Inc. data. Last updated April 5, 2011.

Introduction

Advances in drilling technology and hydraulic fracturing, or “fracking,” have now made it economically feasible to extract oil and natural gas from shale and other impermeable rock formations.¹ However, while such drilling and fracking has been a boon for the oil and gas industry in the United States, it has been a nightmare for Americans exposed to the pollution that accompanies shale development.^a

The oil and gas industry is now poised to take this nightmare global. International private and state-owned oil and gas companies are partnering with U.S. companies, providing capital for U.S. shale development in exchange for the experience of learning drilling and fracking techniques pioneered in the United States.² Many of these companies are also working to secure rights to extract shale oil and shale gas resources worldwide, and in some countries exploratory drilling and fracking is already underway.³

^a For simplicity, the term “shale development” is used in reference to the extraction of oil and natural gas from shale and other impermeable rock formations, including coalbeds, “tight” sandstones and siltstones. Shale development involves the modern combination of horizontal drilling and multi-stage, high-volume fracking.

Because natural gas is a relatively clean-burning fossil fuel, compared to oil and coal, natural gas has been touted as an energy source that could potentially serve as a bridge to a low-carbon future powered by clean and renewable energy resources.⁴ However, looking beyond shale gas combustion to the full environmental impact of shale gas development reveals that shale gas is not the environmentally friendly natural gas that had been envisioned as a bridge. Not only does shale gas development lead to dangerous air and water pollution, but some scientific studies of greenhouse gas emissions from shale gas development suggest that using shale gas instead of coal to generate electricity may actually accelerate climate change in coming decades.⁵

Of course, in contrast to the case of shale gas, there is no pretense that shale oil will offer environmental benefits.

This report reviews the risks and costs of shale development, as demonstrated in the United States, and calls on countries to ban the dangerous practice. To illustrate the global reach of the threat that modern fracking now poses to public health and the environment, the status of shale development in six selected

countries – France, Bulgaria, Poland, South Africa, China and Argentina – is briefly summarized.

History and the Next Wave of Fracking

Fracking is the process of injecting fluid – typically a mixture of water, sand and chemicals – into wells at high pressure to crack rock formations, allowing oil and/or gas contained in these formations to flow more easily into a well.⁶

Fracking is not a new technique. Oil and gas companies have used fracking since the 1860s to stimulate oil-well production.⁷ Halliburton is credited with the first commercial application of fracking to produce natural gas,⁸ and by 2000, fracking was used in 90 to 95 percent of all U.S. oil and gas wells.⁹ However, the scale of modern fracking is a radical departure from that used in conventional oil and gas development.¹⁰

Conventional natural gas drilling targets limestone and other rock formations through which gas readily flows.¹¹ Once a pocket of gas is identified within these permeable formations, a vertical well is drilled down until the reservoir is reached and gas begins to flow into the well.¹² After the flow rate of gas significantly declines, these conventional wells may be fracked to temporarily improve production from the aging well.

In contrast, unconventional natural gas development targets natural gas held in shale, tight sandstone and coalbed formations, which restrict the flow of natural gas unless they are fracked.¹³ Similarly, fracking is essential to free “tight oil” from otherwise impermeable rock formations so it can flow into a well.^{14 b}

The combination of advanced fracking and horizontal drilling technologies has made it economically feasible to extract large quantities of shale oil and shale gas.¹⁵ While fracking allows the oil and gas to flow into a well to begin with, horizontal drilling through a relatively thin layer of shale, for example, gives each well more exposure to the oil and gas in the shale.¹⁶

Once vertical and horizontal drilling is finished, and well casings are cemented, developers inject millions of gallons of fracking fluid to crack apart the rock and prop it open so that the gas can be released.¹⁷ De-

b Shale oil, which requires fracking to extract, is usually referred to as “tight oil” so as to avoid confusion with oil shale.

How Fracking Impacts the Human Right to Water

Water use

Fracking a single shale well requires millions of gallons of water. Widespread shale development would thus compete with essential water needs in regions prone to water shortages.

Water pollution

Shale development presents inherent short-term and long-term risks to water quality.

Climate change

Shale development is likely to accelerate global climate change in the coming decades, contributing to increased variability in seasonal and annual rainfall patterns. Such variability, in the form of either flooding or prolonged droughts, will stress water utility systems.

pending on geology, between 25 and 75 percent of the millions of gallons of fracking fluid used for each well returns to the surface as wastewater.¹⁸ A large volume of salty water containing naturally occurring contaminants is also typically produced at each well as wastewater.¹⁹ Combined, these wastewaters contain the toxic chemicals added to fracking fluid, as well as any radioactive materials and other pollutants leached from deep underground.²⁰

Not content with its technological advances, the oil and gas industry is developing the capacity to increase the amount of fracking fluid and pressure being used in order to generate larger fractures and ultimately extract more oil and gas per well.²¹

The U.S. Experience: Adding Up the Risks and Costs

The increasing scale of drilling and fracking operations needed for shale development has increased the risks and costs of the practice. Modern fracking requires millions of gallons of water for each well, and thus widespread shale development can compete with essential water needs in regions prone to water shortage.²² Public water resources can also be polluted at different stages of shale development or long after the development has occurred, resulting in significant public health costs. Additional public health costs are due to air pollution from modern shale development,

and rural economies suffer from the negative impacts that widespread drilling and fracking have on agriculture and tourism.

Fracking's impact on public water resources

Examples of water pollution in the United States from shale development

Fracking has been implicated in the contamination of water supplies across the United States. ProPublica identified more than 1,000 cases of water contamination near drilling sites, documented by courts, states and local governments around the country prior to 2009.²³ Pennsylvania cited 451 Marcellus Shale gas wells for 1,544 violations in 2010 alone. Notable affected communities include:²⁴

Pavillion, Wyoming: In 2010, the U.S. Environmental Protection Agency released a preliminary study that found possible drinking water contamination near fracking wells and recommended that residents avoid drinking their tap water.²⁵ The U.S. EPA investigated 39 rural water wells and found benzene and methane in wells and groundwater.²⁶ The wells were also contaminated with the fracking fluid additive 2-butoxyethanol phosphate, which has harmful health effects.²⁷ In December 2011, the U.S. EPA released a draft report concluding that fracking likely led to methane contamination of deep groundwater near Pavillion, and that shallow groundwater contamination was likely due to surface spills of fracking wastewater.²⁸

Dimock, Pennsylvania: In 2009, Pennsylvania regulators ordered the Cabot Oil and Gas Corporation to cease all fracking in Susquehanna County after three spills at one well within a week polluted a wetland and caused a fishkill in a local creek.²⁹ The spills leaked 8,420 gallons of fracking fluid containing a Halliburton-manufactured lubricant that is a potential carcinogen.³⁰ Fracking had so polluted water wells that some families could no longer drink from their taps.³¹ Pennsylvania fined Cabot more than \$240,000, but it cost more than \$10 million to transport safe water to the affected homeowners.³² In December 2010, Cabot paid \$4.1 million to 19 families that contended that Cabot's fracking had contaminated their groundwater with methane.³³ In 2012, the U.S. EPA began providing clean drinking water to these families after Cabot had been released of its obligation to do so by the state of Pennsylvania.³⁴

Garfield County, Colorado: Garfield County's 8,000 natural gas wells have inched closer to residential areas.³⁵ A hydrological study found that as the number of gas wells in the heavily fracked county increased, methane levels in water wells also rose.³⁶ State regulators fined EnCana Oil and Gas for faulty well casings that allowed methane to migrate into water supplies through natural faults.³⁷ In 2008, a wastewater pit in Colorado leaked 1.6 million gallons of fluid, which migrated into the Colorado River.³⁸

Parker County, Texas: In 2010, the U.S. EPA determined that fracked gas wells had contaminated a drinking



water aquifer with methane, benzene and other natural gas chemicals that were chemically fingerprinted to the gas well.³⁹

How shale development pollutes freshwater resources

There are many ways that drilling and fracking contaminate public freshwater resources. First, even before fracking fluid chemicals are injected underground, they can be spilled at the sites of wells⁴⁰ or in traffic accidents,⁴¹ resulting in local contamination.

The chemicals used to make fracking fluids are far from safe. Scientists have found that 25 percent of fracking chemicals could cause cancer; 37 percent could disrupt the endocrine system; 40 to 50 percent could affect the nervous, immune and cardiovascular systems; and more than 75 percent could impair sensory organs and the respiratory system.⁴²

A second major pathway of contamination stems from the need to dispose of the several million gallons of fracking wastewater that flows to the surface after each well is fracked. This wastewater contains not only the potentially toxic chemicals used in fracking fluid, but also natural contaminants from deep underground, including total dissolved solids (e.g., salts, barium, strontium), organic pollutants (e.g., benzene, toluene) and normally occurring radioactive material (NORM) such as Radium 226.⁴³ A 2011 *New York Times* investigative report found that nearly three-quarters of the more than 240 Pennsylvania and West Virginia gas wells studied produced wastewater with high levels of radiation, including at least 116 wells with levels that were hundreds of times the U.S. EPA's drinking water standard, and at least 15 wells with levels thousands of times the standard.⁴⁴

Surface water pollution from drilling and fracking occurs with leaks, blowouts and other accidents at the sites of a shale well⁴⁵; spills from traffic accidents while fracking wastewater is being trucked to disposal sites⁴⁶; or spills from the intentional and illegal dumping of fracking wastewater.⁴⁷ In 2010, a shale gas well blowout led to a 75-foot tall geyser of gas and drilling fluid that spilled 35,000 gallons on the ground before it was contained.⁴⁸ In January 2011, approximately 21,000 gallons of fracking wastewater spewed from a Tioga County, Pennsylvania, well when a valve was erroneously left open, releasing



hazardous chloride, sodium, barium and strontium, as well as hydrochloric acid used in the fracking fluid.⁴⁹ Two months after a fire in the company's fracking liquid storage tanks injured three people, a Chesapeake Energy well spurted thousands of gallons of fracking fluid in Bradford County, Pennsylvania, due to an equipment failure.⁵⁰ Pennsylvania had cited Chesapeake Energy 284 times for violations and taken 58 enforcement actions since the beginning of 2008.⁵¹

Also, surface water can be polluted by discharges from treatment facilities that receive fracking wastewater but that are not equipped to treat many of the contaminants this wastewater contains.⁵² For example, between 2008 and 2009 in Pennsylvania, at least half of fracking wastewater went to public sewage plants that were not equipped to treat NORM.⁵³ Pennsylvania's rivers have also had rising levels of bromides, a trend of particular concern because bromides can react with disinfectants during water treatment to form brominated trihalomethanes (THM).⁵⁴ Once formed, THM are difficult and costly to remove from the water supply, and exposure to THM is implicated in cancer and birth defects.⁵⁵ Yet, according to ProPublica, no Pennsylvania wastewater treatment plant was expected to be able to remove total dissolved solids, including bromides and chlorides, from the water until 2013.⁵⁶

In December 2010, the Center for Healthy Environments and Communities (CHEC) at the University of

Pittsburgh tested treated water being discharged into a creek from a treatment facility in Indiana County, Pennsylvania, that had received fracking wastewater. The CHEC analysis found that the average concentration of barium was about 14 times the U.S. EPA drinking water standard, strontium was present at an average concentration of about 746 times the standard, benzene was present at twice the standard and total dissolved solids were present at 373 times the standard.⁵⁷

Drilling and fracking have also caused methane and contaminants in fracking wastewater to seep into underground drinking water supplies directly, without ever reaching the surface.⁵⁸

A National Academy of Sciences study found that average methane concentrations in shallow drinking water wells in active gas areas were 17 times higher than those in non-active areas, possibly due to leaky gas-well casings.⁵⁹ In 2008, a house in Ohio exploded after methane infiltrated its water source, largely because of fracking.⁶⁰ In 2010, after the U.S. EPA instructed Wyoming residents not to drink their water because of contamination from a common fracking fluid, some residents also used fans while bathing to reduce the likelihood of explosions.⁶¹ In 2010, the U.S. EPA determined that two homes in Texas were at risk of explosion because of high levels of natural gas found in their water from nearby fracking operations.⁶²

The U.S. EPA has reported that toxic fracking fluid has contaminated at least one water well in West Virginia and likely others.⁶³ In 2004, in Colorado, a faulty natural gas well casing led to contamination of wa-

ter 4,000 feet away from the well site.⁶⁴ In November 2011, the U.S. EPA released a draft report on contaminated groundwater near drilling and fracking operations in Pavillion, Wyoming, concluding that “the data indicate likely impact to ground water that can be explained by hydraulic fracturing.”⁶⁵

Many of the cases of direct groundwater contamination, either by methane or fracking wastewater, are likely due to faulty casing of the well where the well passes through an aquifer. Multiple, concentric casings are being used to try to reduce the risk of such direct contamination, but human errors will always occur regardless of the robustness of the well casing designs. Yet this is not the only risk to underground resources.

The fact that, depending on geology, 25 to 75 percent of fracking fluid returns to the surface means that millions of gallons of fracking fluid stays underground indefinitely after it is injected into a well.⁶⁶ Once underground, fracking fluid mixes with the naturally occurring brines and is subject to geological forces and chemical processes over the long term, from years to decades. How far and how fast this blend can travel, and how it might change chemically, is impossible to know and control. Potential pathways for contaminants to flow into aquifers include the well into which fracking fluid is injected, nearby abandoned wells,⁶⁷ induced fractures in the shale from fracking, and existing natural fractures in the bedrock.⁶⁸

Modern shale development thus risks irreversible damage to vital underground drinking water resources over the long term. While this possibility may be remote, it is too serious of a risk to accept.

Air pollution from fracking

Shale development results in more emissions of greenhouse gases, smog-inducing compounds and other hazardous air pollutants than conventional oil and gas development. This air pollution comes from the exhaust of generators and compressors at shale well sites, from heavy-duty truck traffic and from the venting of wastewater storage tanks, and it can seriously degrade air quality. This means there are significant health and environmental impacts when examining the full life-cycle of shale gas, and these significant impacts negate some of the benefits that stem from shale gas being a clean-burning fossil fuel.



As for shale oil, there are no air-quality or climate benefits claimed.

Shale gas is composed primarily of methane, which is a potent greenhouse gas.⁶⁹ Recent scientific studies have demonstrated that, due to the amount of fugitive methane released during modern shale gas development as compared to during conventional gas development, any increased use of shale gas instead of coal may actually accelerate climate change in the coming decades, not reduce climate change impacts.⁷⁰ This is despite the fact that shale gas emits significantly less carbon pollution when burned.⁷¹ Crucially, this also assumes that demand for shale gas would displace demand for coal, not supplement it; if such displacement does not happen, then the impact on climate would be far worse.⁷² It is therefore misguided for governments around the world to open up their countries to shale development under the pretext of fighting global climate change.

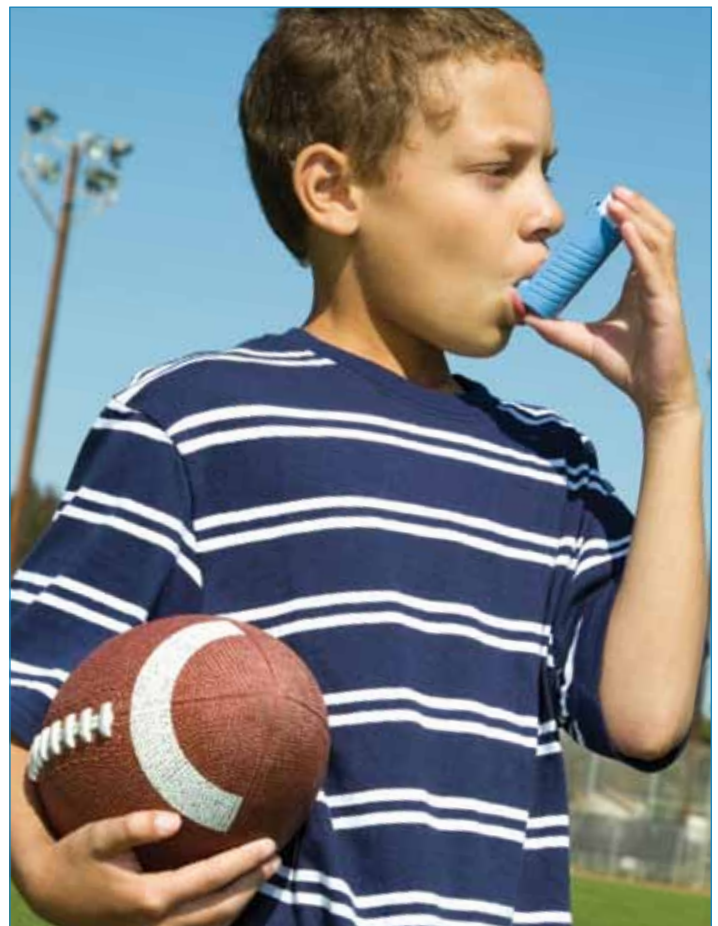
Hazardous air pollutants found near fracking sites include methanol, formaldehyde and carbon disulfide.⁷³ Volatile organic compounds, including nitrogen oxides, benzene and toluene, are also discharged during fracking.⁷⁴ These compounds mix with emissions from heavy-duty truck traffic, large generators and compressors at well sites to form ground-level ozone that can, in turn, combine with particulate matter to form smog.⁷⁵ Long-lasting exposure to smog has been linked to various cancers, heart disease, diabetes and premature deaths in adults, and to asthma, premature birth and cognitive deficits in children.⁷⁶

It is extremely difficult to make direct links between individual health outcomes and unknown exposure levels to air pollutants. However, there are numerous reports of public health problems that coincide with the onset of shale development and that are likely due to the resulting air pollution.

For instance, residents of DISH, Texas, who lived near 11 natural gas compression stations became concerned about the odor, noise and health problems they were experiencing, which included headaches and blackouts. They also observed neurological defects and blindness in their horses.⁷⁷ Their mayor fruitlessly reported these accounts to Texas regulators and eventually hired a private environmental

consultant, who in 2009 found that air samples contained high levels of neurotoxins and carcinogens.⁷⁸ The Texas Commission on Environmental Quality found airborne benzene, which can cause immune disorders and cancer, near Barnett Shale wells at levels of 500 to 1,000 parts per billion – more than five times higher than allowable limits.⁷⁹

In Wyoming, drilling and fracking have caused ground-level ozone pollution to exceed amounts recorded in Los Angeles, affecting the quality of life for Wyoming residents.⁸⁰ In Texas, a hospital system serving six counties with intensive shale gas development reported asthma rates three times higher than the state's average.⁸¹ The natural gas and oil industry in the Barnett Shale area produced more smog-forming emissions during the summer of 2009 than were produced by all motor vehicles in the Dallas-Fort Worth metropolitan area.⁸² Yet ground-level ozone pollution from shale gas development is not just a local problem; it can be transported hundreds of miles by prevailing winds before combining with particulate matter to form smog.⁸³



These accounts illustrate how the serious public health impacts of modern shale development,⁸⁴ and highlight the narrow thinking in assuming that a transition to shale gas will reduce air pollution simply because shale gas burns more cleanly than other fossil fuels.

The U.S. Experience: Exaggerated Claims of Economic Benefits

The shale development rush has not only endangered public health in the United States through pollution of the air Americans breathe and the water Americans drink; it has also harmed local economies. While industry promotes job creation and local investment, proponents typically do not account for the long-term economic damage and the significant erosion of communities' quality of life that can outweigh any benefits.⁸⁵ Many of the purported economic benefits are just a mirage – energy companies based elsewhere typically do not buy drilling and fracking supplies from local businesses, and shale development jobs typically go to transient workers who move from shale play to shale play.⁸⁶

New wells bring fleets of trucks that crowd and damage rural roads and carry potentially hazardous wastewater. New York estimated that, if the state allowed shale gas development, each well would require between 890 and 1,350 heavy-duty truckloads.⁸⁷ Noisy drilling rigs operate 24 hours a day, 7 days a week.⁸⁸ Scenic vistas are replaced with a landscape of gas wells, which lowers property values and harms tourism and recreation industries like hunting and fishing. In Wise County, Texas, properties with gas wells have lost 75 percent of their assessed value.⁸⁹ Natural gas rigs devalue not only the property where they are located, but also the value of neighboring properties.⁹⁰

During construction and drilling, gas wells significantly increase heavy truck traffic, and locals bear the cost of repairing wear and tear on local roads. The Pennsylvania Department of Environmental Protection estimates that building and fracking a well requires 1,000 heavy-duty truck trips.⁹¹ Increased truck traffic damages local infrastructure and can increase the risk of truck accidents on small, rural roads.⁹² Fracking also requires pipelines to transport the gas, which can pose safety hazards from explosions.⁹³ In 2011, a pipeline explosion in Allentown, Pennsylvania,



IMAGE BY NICHOLAS / COMMONS.WIKIMEDIA.ORG

killed five workers; other explosions have occurred elsewhere in Pennsylvania and in Ohio, California, Michigan and Texas, some fatal.⁹⁴

Farmers, whose livelihoods depend on the health of the land, face especially stark choices. Persistently low milk prices have threatened dairy farms in Pennsylvania and New York, and the prospect of gas royalty payments is tempting. Farmers lease their land to gas companies with the promise of minimal impact.⁹⁵ However, livestock have died from drinking water tainted with spilled fracking fluids.⁹⁶ In 2009, 16 cattle died after apparently drinking fluid that escaped from a Louisiana fracking well.⁹⁷ In 2010, Pennsylvania quarantined 28 cows that may have consumed water tainted by a fracking spill that could contaminate their meat.⁹⁸ Organic farmers could lose their premium prices if industrial fracking fluid pollutes their crops or livestock.⁹⁹ Farm sales could be destroyed if pollution threatens livestock, crops or farmland.¹⁰⁰

In contrast to the legacy of environmental pollution that shale development leaves behind, any economic gains from drilling and fracking are short-lived: employment, construction, housing demand and even royalty payments are significant at first, but diminish quickly as well productivity declines and drilling and fracking operations move elsewhere.¹⁰¹ Almost all of the jobs associated with shale development come during the drilling and fracking stage, but it takes less than one year to prepare a well site and conduct

the drilling and fracking.¹⁰² This means that industry employees, most of whom are transient workers with shale development experience, just move from new well to new well as the number of drilled wells increases.¹⁰³ Also, there is considerable uncertainty over estimates of the amount of shale gas reserves that is technically recoverable using current technology, and over how long individual wells will actually be productive. If production falls more rapidly than expected, as some industry analysts anticipate,¹⁰⁴ then there would be smaller royalty checks and fewer production-phase jobs over the long term. In August 2011, it was reported that some shale gas producers received subpoenas from the U.S. Securities and Exchange Commission for documents on actual well production and reserve estimates, after the *New York Times* reported concerns expressed by some in the industry and government that the shale boom has been overstated.¹⁰⁵

Finally, estimates of the amount of technically recoverable – not necessarily economically recoverable – shale resources in the United States have varied widely.¹⁰⁶ In January 2012, the U.S. Energy Information Administration cut its estimate of technically recoverable shale gas by about 42 percent from the estimate it used just one year earlier.¹⁰⁷ This raises serious questions about whether countries should stake their energy futures on shale resources, given that the U.S. EIA's estimates of international shale resources may be similarly flawed.¹⁰⁸ Indeed, initial exploratory drilling in Poland conducted by Exxon has not yielded commercially viable production levels.¹⁰⁹

Fracking Around the World

Mineral rights ownership

In the United States, landowners typically own the right to develop oil and gas reserves beneath their own private land.¹¹⁰ As a consequence, the oil and gas industry has had a natural alliance with landowners who seek individual financial gain from selling leases and receiving royalty payments.¹¹¹

According to Ben van Beurden, head of Shell Chemical, “[shale gas development] works a whole lot better if the mineral rights to the gas actually belong to the land owners.”¹¹² He continued, “[i]n places like north-

Snapshot of Global Shale Gas Activity

Africa: Royal Dutch Shell has led the push to drill and frack for shale gas in South Africa's Karoo Basin.¹¹⁵ The Sirt Basin, in Libya, and the Ghadames Basin, which underlies parts of Algeria, Tunisia and Libya, are also targeted for shale gas development.¹¹⁶ In Tunisia, Cygam Energy has begun exploratory drilling and fracking, and Chinook Energy Inc. has leased 3 million acres of land.¹¹⁷ In Morocco, the national oil and gas company has been studying its shale gas potential.¹¹⁸

Oceania & Asia: ExxonMobil, Royal Dutch Shell, Chevron, BP and ConocoPhillips are among the foreign companies investing in China's shale resources — be it shale oil or shale gas.¹¹⁹ ConocoPhillips and New Standard Energy, an Australian company, are partnering to develop shale gas resources in western Australia's Canning Basin, although New South Wales, Australia's most populated province, has temporarily suspended shale development.¹²⁰ In New Zealand, the Taranaki Regional Council has granted permission for fracking of conventional natural gas wells to continue.¹²¹

Latin America: In Argentina, exploratory drilling has begun in the Neuquén Basin, led by Apache Corporation, Total and ExxonMobil.¹²² In October 2009, Uruguay's government-owned petroleum company entered a contract with Texas-based Schuepbach Energy LLC to assess its shale gas potential.¹²³ While shale development is not actively underway in Mexico, Brazil, Chile, Paraguay and Bolivia, these countries are believed to each have significant shale resources.¹²⁴

Europe: In June 2011, France became the first country to ratify a nationwide ban on fracking.¹²⁵ In January 2012, Bulgaria also enacted a nationwide ban on the practice.¹²⁶ Exploration in England, in Northern Ireland and in the German province of North Rhine-Westphalia has been suspended as of April 2011.¹²⁷ Chevron, ConocoPhillips and ExxonMobil have each leased over 1 million acres in Poland, and ExxonMobil has leased an additional 2 million acres combined in Germany and the Netherlands.¹²⁸ In November 2011, the Scottish government granted its first license to allow fracking,¹²⁹ and Ireland is expected to also grant exploratory shale drilling licenses, pending a government review of environmental impacts.¹³⁰

western Europe, mineral rights are being held by the state so the only thing as a land owner you have is inconvenience.”¹¹³

Indeed, in many countries, governments own and control subsurface mineral rights.¹¹⁴ On one hand, this means that the oil and gas industry does not benefit in these countries from private landowners who apply public pressure on their governments to expand drilling and fracking in hopes of gaining financially. But, on the other hand, state control over mineral rights means that national governments around the world may view the potential revenues from selling access to the highest-bidding oil and gas companies as worth the public risks and costs of shale development.

France

If French landowners receive both authorization and a concession from the French government, they do have the right to extract and dispose of minerals on their land.¹³¹ However, the national government or a third party can also develop these same resources through the same permitting and concession process, after a public enquiry and bidding process.¹³²

In 2010, numerous companies leased land in the Paris Basin, which is targeted as a resource of both shale gas and tight oil, and in the Southeast Basin, which is targeted for shale gas.¹³³ The French government issued exploration permits to many of these companies and their partners, including Vermillion Energy, Total SA, Torreador Resources in partnership with Hess, and Schuepbach Energy, an American company that was in partnership talks with the French energy company GDF Suez.¹³⁴ However, French citizens cried foul when they learned that the permits had been issued without public deliberation.¹³⁵

Activists began circulating a petition in January 2011 that initially led to a moratorium on fracking in France, followed in June 2011 by a national ban on the practice.¹³⁶ France’s Environment Minister, Nathalie Kosciusko-Morizet, stated “[w]e have seen the results in the U.S. There are risks for the water tables and these are risks we don’t want to take.”¹³⁷

Total SA maintains that its permit to develop shale gas in the Southeast Basin should not have been revoked and has challenged France’s ban on fracking.¹³⁸

Bulgaria

In Bulgaria, potential shale gas resources are owned by the state, not by landowners.¹³⁹ In June 2011, Chevron agreed with the Bulgarian government to pay €30 million for a five-year permit to conduct exploratory shale gas drilling on 4,400 square kilometers of land near the city of Novi Pazar.¹⁴⁰ The Bulgarian Prime Minister, Boyko Borisov, rejected charges by the leader of an opposition party that the agreement had been finalized.¹⁴¹ The resulting confusion, combined with concerns about the environmental impacts of fracking, fueled demonstrations against the deal.¹⁴² Months later, this grassroots political pressure culminated in the Bulgarian government revoking the agreement with Chevron and passing a national ban on fracking.¹⁴³

Poland

Poland has the highest estimated reserves of shale gas in Europe,¹⁴⁴ and the country’s government has welcomed the industry with open arms.¹⁴⁵ ExxonMobil, Chevron, Total, Realm Energy and Talisman are among the oil and gas companies seeking to develop



SHALE GAS PROTEST IN BULGARIA. IMAGE BY ©ALEXHG1 / DREAMSTIME.COM

shale gas reserves in Poland.¹⁴⁶ By 2012, over 100 licenses for shale gas exploration had been granted in the Baltic and Podlasie Basins by the national government of Poland,¹⁴⁷ which owns all gas deposits and transfers development rights through concessions.¹⁴⁸

The Polish government has pushed for exploratory drilling to be intensified so that shale gas production can begin as soon as 2014.¹⁴⁹ However, the government's efforts to commercialize shale gas in Poland have been complicated by charges of corruption, in January 2012, involving government officials and the shale gas industry.¹⁵⁰ The government charged that bribes had been offered by the industry, and accepted by government officials, to secure shale gas leases.¹⁵¹

Rather than award these licenses through a competitive bidding process, the Polish government awarded them at low costs on a first-come, first-served basis, and some have argued this has made the process prone to corruption.¹⁵²

South Africa

Royal Dutch Shell has led the push for access to shale gas in South Africa,¹⁵³ where shale gas development rights are owned by the state, not by landowners.¹⁵⁴ In 2009, the Petroleum Agency South Africa granted permission to Shell to conduct an assessment of shale gas resources in the Karoo Basin.¹⁵⁵ However, farmers and environmentalists in the area expressed concerns about the risks and costs of drilling and fracking for shale gas.¹⁵⁶ In April 2011, South Africa's cabinet acknowledged these concerns and established a moratorium

on shale gas exploration in the Karoo Basin to allow time for a government study of the impacts of fracking.¹⁵⁷ This moratorium was set to expire at the end of February 2012, pending recommendations in the government study.¹⁵⁸

On November 11, 2011 the National Planning Commission, an advisory body to the South African government, released its National Development Plan (NDP).¹⁵⁹ In addressing energy, the NDP recommends enabling "exploratory drilling to identify economically recoverable coal seam and shale gas reserves, while environmental investigations will continue to ascertain whether sustainable exploitation of these resources is possible."¹⁶⁰ The NDP calls for shale gas development and investment in shale gas electricity generation to be "fast tracked," provided that "environmental concerns are alleviated"¹⁶¹ and "provided the overall environmental costs and benefits outweigh the current costs and benefits associated with South Africa's dependence on coal, or with the alternative of nuclear power."¹⁶²

However, widespread drilling and fracking in the Karoo could jeopardize the NDP's objectives to provide clean drinking water for all and reduce urban water demands by 2030,¹⁶³ and, with respect to climate change, scientific studies suggest that replacing one fossil fuel with another is likely misguided.¹⁶⁴

China

China's National Energy Administration has reportedly integrated shale gas into its national energy plan.¹⁶⁵ The chairman of Sinopec, China's second-largest oil company, believes that China could overtake the United States in shale gas.¹⁶⁶ In November 2009, the United States and China launched the U.S.-China Shale Gas Initiative¹⁶⁷ to facilitate Chinese efforts to gain technical expertise in shale gas development.¹⁶⁸

Royal Dutch Shell, which has \$4 billion in total energy investments in China, has teamed up with PetroChina.¹⁶⁹ Together, these companies drilled and fracked China's first exploratory horizontal shale gas well in March 2011 in the Sichuan Basin. Three months later, China's Ministry of Land Resources initiated bidding rounds for commercial shale gas development permits.¹⁷⁰ China, which maintains state ownership of oil and gas resources, has limited initial commercial development access to domestic companies.¹⁷¹



Fracking would risk the food and freshwater resources on which millions of Chinese depend. The Sichuan Basin lies beneath one of China's most populated and agriculturally important areas, Sichuan Province, which is home to almost 100 million people and has farmland that supplies a significant portion of China's staple foods.¹⁷² Despite recent government efforts, environmental regulatory protections in China are lacking.¹⁷³

Argentina

In Argentina, either the national government or provincial governments own oil and gas rights.¹⁷⁴ According to the U.S. EIA, Argentina has the third highest amount of technically recoverable shale gas in the world, primarily in the Neuquén Basin, and shale gas exploration has commenced.¹⁷⁵ The Argentinian oil and gas company YPF is partnering with Apache Corporation, an American company that has about 1 million acres in shale leases in Argentina.¹⁷⁶ In December 2010, Apache Corporation conducted the first multistage fracking of a horizontal shale gas well in Latin America.¹⁷⁷

In addition to its gas resources, the Neuquén Basin is expected to hold significant quantities of tight oil.¹⁷⁸ Total, ExxonMobil and EOG Resources have each begun to invest in developing these resources.¹⁷⁹ However, widespread drilling and fracking for oil and gas in the Neuquén basin is likely to have negative impacts on tourism that is important to the economy of Neuquén Province.¹⁸⁰

Shale development would also place large demands on water resources in the region¹⁸¹ and, as such, can be expected to exacerbate environmental justice concerns about access to potable water in Neuquén Province.¹⁸²

Conclusion

Natural gas has long been considered as an alternative fuel, both for transportation and for generating electricity, that can serve as a bridge to a future powered by clean, renewable energy resources.¹⁸³ However, shale gas is not the natural gas that had been envisioned.

The rapid expansion of shale gas development and fracking in the United States has resulted in significant environmental and public health problems, and



become an ongoing public health and environmental experiment. Many of these problems are inherent to the practice and cannot be avoided through regulation.

Taken together, spills of toxic fracking fluid and fracking wastewater,¹⁸⁴ water well contamination from the underground migration of methane¹⁸⁵ and toxic fracking fluid,¹⁸⁶ local and regional air pollution problems from shale development,¹⁸⁷ explosions at the sites of shale wells,¹⁸⁸ and substantial emissions of the global warming pollutant methane during drilling and fracking¹⁸⁹ make the dangers of shale development clear.

Countries not yet exposed to the risks and costs of drilling and fracking have an opportunity to choose a different path, one that “meets the needs of the present without compromising the ability of future generations to meet their own needs.”¹⁹⁰ Enacting a national ban on fracking and investing in the deployment of energy efficiency and renewable energy technologies will set a sustainable course.

Endnotes

- 1 Groundwater Protection Council and ALL Consulting. "Modern Shale Gas Development in the United States: A Primer." Prepared for the U.S. Department of Energy. April 2009 at 8 and 9; American Petroleum Institute. [Brochure]. "Freeing up energy. Hydraulic fracturing: Unlocking America's natural gas resources." July 19, 2010 at 1 and 2; National Petroleum Council (NPC). [Draft report]. "Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources." September 15, 2011 at 2-33.
- 2 Hook, Leslie. "Cnooc strikes second U.S. shale deal." *Financial Times*. January 31, 2011; Boxell, James. "Total invests billions in shale gas." *Financial Times*. January 6, 2012; "Spain's Repsol acquires U.S. shale stake for \$1 billion." *Latin American Herald Tribune*. December 22, 2011; Sharma, Rakesh. "Oil India plans to buy shale gas assets in U.S., Australia." *The Wall Street Journal*. January 16, 2012.
- 3 Molchanov, Pavel and Alex Morris. Raymond James & Associates, Inc. [Industry Brief]. "Can shales double the world's natural gas reserves?" April 18, 2011 at 3.
- 4 Flavin, Christopher and Nicholas Lenssen. "Power Surge: Guide to the Coming Energy Revolution." W.W. Norton: New York. 1994 at 91 and 92; Energy Modeling Forum. Stanford University. "Natural Gas, Fuel Diversity and North American Energy Markets." Report 20. September 2003 at 1; Podesta, John D. and Timothy E. Wirth. Center for American Progress. "Natural Gas: A Bridge Fuel for the 21st Century." August 10, 2009 at 1; Jaffe, Amy M. "Shale gas will rock the world." *The Wall Street Journal*. May 10, 2010.
- 5 Pétron, Gabrielle et al. "Hydrocarbon emissions characterization in the Colorado Front Range - A pilot study." *Journal of Geophysical Research*. 2012 [In press]; Wigley, Tom M.L. "Coal to gas: the influence of methane leakage." *Climatic Change*, Vol. 108, No. 3. October 2011 at 607; Howarth, Robert W. et al. "Methane and the greenhouse-gas footprint of natural gas from shale formations." *Climatic Change*. Vol. 106. June 2011 at 679; Tyndall Centre for Climate Change Research. University of Manchester. "Shale gas: a provisional assessment of climate change and environmental impacts." January 2011 at 6.
- 6 Arthur, J.D. et al. "Hydraulic fracturing considerations for natural gas wells of the Marcellus shale." Prepared for presentation at The Ground Water Protection Council. Cincinnati, Ohio. September 21-24, 2008 at 8; Harper, John. Bureau of Topographic and Geologic Survey. "The Marcellus Shale—An Old 'New' Gas Reservoir in Pennsylvania." Bureau of Topographic and Geologic Survey. *Pennsylvania Geology*. Vol. 38, No. 1. Spring 2008 at 10.
- 7 Montgomery, Carl T. and Michael B. Smith. NSI Technologies. "Hydraulic Fracturing: History of an Enduring Technology." *Journal of Petroleum Technology*. Vol. 62, Iss. 12. December 2010 at 27.
- 8 Halliburton. [Press release]. "Halliburton celebrates 50-year anniversary of process that 'energized' oil and gas industry." June 21, 1999.
- 9 Jaffe, Mark. "Political fracture fight over oil, gas extraction process of 'fracking' moves to Congress." *Denver Post*. August 2, 2009; Carillo, Victor. Texas Railroad Commission, Representing the Interstate Oil and Gas Compact Commission. Testimony in front of House Energy and Commerce Committee, 109th Congress. February 10, 2005.
- 10 "Understanding drilling technology." *Marcellus Shale*. Iss. 6. January 2012 at 3.
- 11 Groundwater Protection Council and ALL Consulting (2009) at 7, 8 and 15.
- 12 Arthur, J.D. et al. at 7 and 8.
- 13 Groundwater Protection Council and ALL Consulting (2009) at 15.
- 14 National Petroleum Council (2011) at 2-33 and 2-34.
- 15 Groundwater Protection Council and ALL Consulting (2009) at 15.
- 16 *Ibid.*
- 17 United States Environmental Protection Agency (U.S. EPA). "Plan to Study the Potential Impacts of Hydraulic Fracturing on 95 Drinking Water Resources." EPA/600/R-11/122. November 2011 at 15 and 22.
- 18 Groundwater Protection Council and ALL Consulting (2009) at 66; U.S. EPA (November 2011) at 23.
- 19 U.S. EPA (November 2011) at 43.
- 20 *Ibid.*
- 21 Wethe, David. "Super fracking goes deeper to pump up natural gas production." *Bloomberg News*. January 11, 2012; Kusnetz, Nicholas. "Oh, Canada's become a home for record fracking." *ProPublica*. December 28, 2012.
- 22 Collier, Kiah. "Fracking gives Texas another oil boom, but at huge water costs." *Standard Times* (San Angelo, Texas). June 30, 2011.
- 23 Lustgarten, Abraham. "Buried Secrets: Is natural gas drilling endangering U.S. water supplies?" *ProPublica*. November 13, 2008.
- 24 Volz, Conrad. Center for Healthy Environments and Communities, University of Pittsburgh Graduate School of Public Health. Testimony on Natural Gas Drilling, Public Health and Environmental Impacts. Subcommittee on Water and Wildlife. Committee on Environment and Public Works. United States Senate. April 12, 2011 at 3 and 4.
- 25 Clayton, Mark. "Fracking for natural gas: EPA hearings bring protests." *Christian Science Monitor*. September 13, 2010.
- 26 Smith, Jack Z. "The Barnett Shale search for facts on fracking." *Fort Worth (Texas) Star-Telegram*. September 5, 2010.
- 27 Harman, Greg. "Fracking's short, dirty history." *San Antonio (Texas) Current*. January 5, 2011 - January 11, 2011.
- 28 U.S. EPA. [Draft]. "Investigation of Ground Water Contamination near Pavillion, Wyoming." December 8, 2011 at xi and xiii.
- 29 Basler, George. "Pa. orders halt to Cabot drilling." *Binghamton (New York) Press & Sun-Bulletin*. September 26, 2009.
- 30 *Ibid.*
- 31 Mouawad, Jad and Clifford Krauss. "Dark side of natural gas." *New York Times*. December 8, 2009.
- 32 Harman (2011).
- 33 Wooton, Casey. "Fracking goes green." *Houston (Texas) Business Journal*. April 8, 2011.
- 34 Maykuth, Andrew. "EPA to deliver water in Dimock." *The Philadelphia Inquirer*. January 19, 2012.
- 35 Olsen, Erik. "Natural gas and polluted air." Video. *New York Times*. February 2011.
- 36 Smith (2010).
- 37 Harman (2011).
- 38 Lustgarten, Abraham. "How the West's energy boom could threaten drinking water for 1 in 12 Americans." *ProPublica*. December 21, 2008.
- 39 Loftis, Randy Lee. "EPA: 2 homes at risk of explosion." *Dallas (Texas) Morning News*. December 8, 2010.
- 40 Whong, Jason. "Police probe fracking fluid spill in Bradford County." *Star Gazette* (Bradford County, Pennsylvania). January 11, 2012.
- 41 Reppert, Julie. "Collision spills fracking fluid on state route." *Sun Gazette* (Williamsport, Pennsylvania). December 27, 2011.
- 42 Colborn, Theo et al. "Natural Gas Operations from a Public Health Perspective." *International Journal of Human and Ecological Risk Assessment*. September-October 2011 at abstract and 9.
- 43 *Ibid.* at 11; Groundwater Protection Council and ALL Consulting (2009) at 70 to 71; 76 U.S. Federal Register. "Notice of final 2010 effluent guidelines program plan." 66286-66304 (October 26, 2011) at 66296.
- 44 Urbina, Ian. "Regulation lax as gas wells' tainted water hits rivers." *New York Times*. February 26, 2011.
- 45 Maykuth (2010); "Denbury plugs North Dakota oil well leak." *Reuters*. September 3, 2010; Winter, Deena. "Welcome to boomtown: oil production raises health concerns." *Great Plains Examiner* (Bismarck, North Dakota). January 10, 2012.
- 46 York, Kate and Brad Bauer. "Fracking wastewater leaked onto Ohio roads." *The Marietta Times* (Woodsville, Ohio). December 24, 2011.

- 47 Hogan, Colin. "Trucker jailed after illegally dumping drilling chemicals." *Morning Times* (Towanda, Pennsylvania). December 3, 2011.
- 48 Maykuth (2010).
- 49 Aaron, Jeffrey. "Anatomy of a well blowout." *Elmira (New York) Star-Gazette*. March 13, 2011.
- 50 McAllister, Edward. "Pennsylvania nat gas well has blowout during fracking." *Reuters*. April 21, 2011; "Crews stop flow of drilling fluid from Marcellus Shale well in Pa." *Associated Press*. April 22, 2011.
- 51 Legere, Laura. "After blowout, most evacuated families return to their homes in Bradford County." *Scranton (Pennsylvania) Times Tribune*. April 21, 2011.
- 52 U.S. Federal Register (2011) at 66296.
- 53 Urbina (February 2011).
- 54 Levy, Marc. "Pa. asks natural gas drillers to stop taking wastewater to 15 treatment plants for discharge." *Associated Press*. April 19, 2011; Hopey, Don. "Bromide: a concern in drilling wastewater." *Pittsburgh Post-Gazette*. March 13, 2011.
- 55 *Ibid.*
- 56 Sapein, Joaquin. "With natural gas drilling boom, Pennsylvania faces an onslaught of wastewater." *ProPublica*. October 3, 2009.
- 57 Volz (2011) at 3 and 4.
- 58 Urbina, Ian. "A tainted water well, and concern there may be more." *New York Times*. August 3, 2011; U.S. EPA (December 2011) at xi and xiii; Osborn, Stephen G. et al. "Methane contamination of drinking water accompanying gas well drilling and hydraulic fracturing." *Proceedings of the National Academy of Sciences*. April 14, 2011 at 2 and 4.
- 59 *Ibid.* at 2 and 4.
- 60 Ohio Department of Natural Resources Division of Mineral Resources Management. "Report on the Investigation of the Natural Gas Inversion of Aquifers in Bainbridge Township of Geauga County, Ohio." September 1, 2008 at 3 to 5.
- 61 Harman (2011).
- 62 Loftis (2010).
- 63 Urbina (August 2011).
- 64 Horwitt, Dusty. Senior Counsel for the Environmental Working Group. [Public testimony]. Oversight Hearing on the Revised Environmental Impact Statement on Hydraulic Fracturing and New York City's Upstate Drinking Water Supply Infrastructure. Before the New York City Council Committee on Environmental Protection. September 22, 2011 at 2.
- 65 U.S. EPA (December 2011) at xiii.
- 66 U.S. EPA (November 2011) at 23.
- 67 Horwitt (2011) at 4.
- 68 "Jointing and Fracturing in the Marcellus Shale." *Marcellus Shale*. Iss. 5. August 2011 at 3.
- 69 Tyndall Centre for Climate Change Research (2011) at 6; Groundwater Protection Council and ALL Consulting (2009) at 14 and 74.
- 70 *Ibid.* at 6; Pétron et al. (2012); Wigley (2011) at 607; Howarth et al. (2011) at 679.
- 71 *Ibid.* at 686 to 687.
- 72 Massachusetts Institute of Technology. "The future of natural gas: An interdisciplinary MIT study." June 9, 2011 at 69 and 70; Tyndall Centre for Climate Change Research, University of Manchester. "Shale gas: a provisional assessment of climate change and environmental impacts." January 2011 at 6; Brown, Stephen P.A. et al. Resources for the Future. "Natural gas: a bridge to a low-carbon future?" December 2009 at 10.
- 73 United States House of Representatives. Committee on Energy and Commerce. [Minority Staff Report]. "Chemicals used in hydraulic fracturing." April 2011 at 11; Harman (2011); Lee, Mike. "State worried about air pollution near Barnett Shale wells." *Star-Telegram (Texas)*. November 22, 2009; Burnett, John. "Health issues follow natural gas drilling in Texas." *National Public Radio*. November 3, 2009.
- 74 Steingraber, Sandra. Ithaca College. Testimony on Health Impacts of Hydraulic Fracturing Techniques. Assembly Standing Committee on Environmental Conservation and Health. New York State Assembly. May 26, 2011 at 11; Colborn (2011) at 5.
- 75 Steingraber (2011) at 11; Colborn (2011) at 5.
- 76 Steingraber (2011) at 11 and 12.
- 77 Burnett (2009).
- 78 *Ibid.*
- 79 Lee (2009).
- 80 Gruver, Mead. "Wyoming is beset by a big-city problem: Smog." *Associated Press*. March 8, 2011.
- 81 Urbina (February 2011).
- 82 Armendariz, Al. Environmental Defense Fund. "Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements." January 26, 2009 at 1, 7, 8 and 18.
- 83 Canada-United States Air Quality Committee. "Ground-level Ozone: Occurrence and Transport in Eastern North America." Subcommittee 1, Program Monitoring and Reporting. March 1999 at 14.
- 84 Bamberger, Michelle and Robert E. Oswald. "Impacts of gas drilling on human and animal health." *New Solutions, Scientific Solutions*. Vol. 22. Iss. 1. January 2012.
- 85 Considine, Timothy J. et al. "The economic impacts of the Pennsylvania Marcellus Shale natural gas play: an update." The Pennsylvania State University, Department of Energy and Mineral Engineering. May 24, 2010.
- 86 Barth, Jannette M. PhD., "Hydrofracturing offers short-term boom, long-term bust." *Engineering News-Record*. March 7, 2011; Marcellus Shale Education & Training Center (MSETC). "Pennsylvania Marcellus Shale Workforce Needs Assessment." MSETC Needs Assessment Series—Summer 2011. June 2011 at 8.
- 87 New York State. Department of Environmental Conservation. "Revised Draft Supplemental General Draft Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs." September 7, 2011 at 6-113 and 6-114.
- 88 Maykuth (2009).
- 89 Heinkel-Wolfe, Peggy. "Drilling can dig into land value." *Denton (Texas) Record Chronicle*. September 18, 2010.
- 90 Grace, Tom. "Otsego committee rejects hydro-fracking ban." *Oneonta (New York) Daily Star*. May 27, 2010.
- 91 Fears, Darryl. "Sitting atop huge gas reserve, Md. debates drilling practice." *Washington Post*. March 28, 2011.
- 92 Barth (2011).
- 93 Volz, Conrad. University of Pittsburgh. Graduate School of Public Health. Center for Healthy Environments and Communities. "Methane and other types of pipelines being proposed as a result of shale gas expansions." August 23, 2010.
- 94 Cauchon, Dennis. "Allentown pipeline explosion revives natural gas worries." *USA Today*. February 12, 2011.
- 95 Hamill, Jim. "Couple regrets gas well lease." *WNEP*. October 28, 2010.
- 96 Bamberger and Oswald (2012).
- 97 Lustagraton, Abraham. "16 cattle drop dead near mysterious fluid at gas drilling site." *ProPublica*. April 30, 2009.
- 98 "Pennsylvania quarantine cattle over gas drilling fluid." *Reuters*. July 1, 2010.
- 99 Blacklock, Colleen. [Public comments to the State of New York on the draft Supplemental Generic Environmental Impact Statement of the Oil, Gas and Solution Mining Regulatory Program]. "Potential Impacts of Gas Drilling on Agriculture in the Marcellus Shale Region of New York State." December 11, 2008.
- 100 Bamberger and Oswald (2012).

- 101 Phillips Long, Barbara. "Lectures: No time to waste in fracking decisions." *Carlisle (Pennsylvania) Sentinel*. February 13, 2011.
- 102 MSETC (2011) at 19 and 21.
- 103 *Ibid.* at 8.
- 104 Berman, Arthur E. and Pittinger, Lynn F. "U.S. shale gas: less abundance, higher cost." *The Oil Drum*. August 5, 2011.
- 105 Fowler, Tom. "SEC subpoenas records on shale gas production." *Houston (Texas) Chronicle*. August 9, 2011.
- 106 U.S. Geological Survey. [Press release]. "USGS Releases New Assessment of Gas Resources in the Marcellus Shale, Appalachian Basin." August 23, 2011; U.S. Energy Information Administration (U.S. EIA). "Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays." July 2011 at 5 to 7.
- 107 U.S. EIA. "Annual Energy Outlook 2012: Early release outlook." January 23, 2012.
- 108 *Ibid.*; Advanced Resources International, Inc. "World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States." Prepared for the U.S. EIA, Office of Energy Analysis. April 2011 at 1-5.
- 109 Carrol, Joe. "Exxon shale failure in Poland may lengthen Gazprom's shadow." *Bloomberg News*. February 1, 2012.
- 110 Cogan, John P. and J. Elizabeth Molino. "Chapter 31: USA." In Global Legal Group. (2011). *The international comparative legal guide to: gas regulation 2011*. London: Global Legal Group Ltd. at 311; "Fracking here, fracking there." *The Economist*. November 26, 2011.
- 111 *Ibid.*; "N.Y. state's fracking hearings move to the Catskills." *Associated Press*. November 29, 2011; "Landowners pan latest delay in NY gas drilling." *Associated Press*. December 1, 2011.
- 112 Turley, Andrew. "European fracking boom 'doubtful'." *Chemistry World*. October 17, 2011.
- 113 *Ibid.*
- 114 "Fracking here, fracking there." *The Economist*. November 26, 2011; Global Legal Group (2011). "Fracking stirs controversy in South Africa." *The Guardian*. September 2, 2011.
- 115 Blaine, Sue. "Fracking: Karoo shale beds spark debate." *The Financial Times*. December 1, 2011.
- 116 Advanced Resources International, Inc. (2011) at VIII-1.
- 117 *Ibid.* at VIII-6.
- 118 *Ibid.* at IX-7.
- 119 *Ibid.* at XI-8, XI-9 and XI-25; Reed, Stanley and Dexter Roberts. "Shell is 'Welcome Barbarian' in China's shale gas." *Bloomberg News*. November 18, 2011; "Sinopec Group Unit, Exxon sign agreement on shale gas area." *Bloomberg News*. July 18, 2011.
- 120 "Firms sign Canning Basin gas deal." *ABC News, Australia*. July 14, 2011.
- 121 "Report gives fracking all clear." *Taranaki Daily News* (New Zealand). November 24, 2011. Taranaki Regional Council. "Hydrogeologic Risk Assessment of Hydraulic Fracturing for Gas Recovery in the Taranaki Region." November 24, 2011.
- 122 Advanced Resources International, Inc. (2011) at IV-2; Dar, Vinod. Dar & Company. "Shale Gas Exploration Goes Global with Drilling in Argentina." February 3, 2011 at 1 and 2; Turner, Taos. "Americas Petrogas, Exxon in Argentina shale pact." *The Wall Street Journal*. August 30, 2011.
- 123 Advanced Resources International, Inc. (2011) at IV-23.
- 124 *Ibid.* at 1-5.
- 125 Patel, Tara. "France Vote Outlaws 'Fracking' Shale for Natural Gas, Oil Extraction." *Bloomberg News*. July 1, 2011.
- 126 Konstantinova, Elizabeth and Joe Carroll. "Bulgaria bans gas fracking, thwarting Chevron drilling plan." *Bloomberg News*. January 19, 2012.
- 127 Broughton, Elizabeth. "Complacency fury over gas." *Blackpool Gazette*. January 19, 2012; Clarke, Liam. "Gas fracking is put on hold by Northern Ireland Assembly." *Belfast Telegraph*. December 7, 2011; Nicola, Stefan. "Public slows Exxon's German shale gas bid." *United Press International*. April 13, 2011.
- 128 Molchanov, Pavel and Alex Morris. "Can shales double the world's natural gas reserves?" Raymond James & Associates, Inc. Industry Brief. April 18, 2011 at 3.
- 129 Fyall, Jenny. "'Fracking' for gas given the green light." *Scotland on Sunday*. November 5, 2011; Blair, David. "Lancashire yields huge shale gas find." *Financial Times*. September 21, 2011.
- 130 Mills, Erica. "Ireland orders investigation into shale gas fracking." *Natural Gas Europe*. October 6, 2011.
- 131 Lauriol, Thierry and Valeria Vidoni. "Chapter 12: France." In Global Legal Group (2011) at 89 and 90.
- 132 *Ibid.*
- 133 Advanced Resources International, Inc. (2011) at VII-3 and VII-7; Sheehan, John. "Shale Gas: Promising Prospects Worldwide." *Journal of Petroleum Technology, Special Section, Shale*. July 2011 at 35.
- 134 *Ibid.*; Patel (2011).
- 135 Griffith, Benjamin E. "Fracking for Shale Gas: Energy Security & Sustainable Water Resources." Paper for the World Jurist Association 24th Biennial Congress on the Law of the World, National Legal Cultures in a Globalized World in Prague, Czech Republic. October 27, 2011 at 18 and 19; Patel, Tara. "The French Public Says No to 'Le Fracking'." *Bloomberg News*. March 31, 2011.
- 136 Patel (March 31, 2011); Patel (July 1, 2011).
- 137 Griffith (2011) at 19.
- 138 "Total to challenge French fracking ban." *United Press International, Inc.* November 29, 2011; Watkins, Eric. "Total to challenge French government's revocation of shale gas permit." *Oil & Gas Journal; International Petroleum and News Technology*. November 20, 2011; "Total appeals shale gas ban." *The Connexion*. January 18, 2012.
- 139 Sirlishtov, Kostadin and Pavlin Stoyanoff. "Chapter 9: Bulgaria." In Global Legal Group (2011) at 62.
- 140 "Bulgaria grants Chevron shale gas permit." *Oil & Gas Journal*. June 27, 2011 at 8.
- 141 "No shale gas contract with Chevron yet, Bulgarian PM assures." *Sofia (Bulgaria) News Agency*. November 18, 2011.
- 142 "Latest shale gas protest help in Bulgaria's Sofia." *Sofia (Bulgaria) News Agency*. November 26, 2011; Federation of Young European Greens. "Bulgarian Young Greens fight against gas extraction projects." Member Organization News. Retrieved December 8, 2011 from <http://www.fyeg.org/main/index.php/news/mo-news/257-bulgarians-young-greens-fight-against-gas-extraction-project>; "Bulgarians protest, seek moratorium on shale gas." *Reuters*. January 14, 2012.
- 143 Konstantinova, Elizabeth. "Bulgaria votes to ban gas fracking, thwarting Chevron." *Bloomberg News*. January 18, 2012.
- 144 Advanced Resources International, Inc. (2011) at 1-5.
- 145 Dittrick, Paula. "Poland shale gas could change European supply mix." *Oil & Gas Journal*. November 7, 2011.
- 146 "Exxon starts fracking hard in Eastern Europe." *Forbes*. October 3, 2011; Advanced Resources International, Inc. (2011) at V-13; Sheehan (2011) at 32 and 34.
- 147 *Ibid.* at 32; "Shale gas in Poland: Down to earth." *The Economist*. January 15, 2012.
- 148 Rogozik, Artur and Patrycja Osinska-Schroeijers. "Chapter 29: Poland." In Global Legal Group (2011) at 236.
- 149 Strzelecki, Marek. "Poland seeks shale gas drilling boost for 2015 production start." *Bloomberg News*. January 19, 2012.
- 150 "Corruption scandals hits Poland's shale gas sector." *Warsaw Business Journal* (Poland). January 11, 2012.
- 151 "Shale gas in Poland: Down to earth." *The Economist*. January 15, 2012.
- 152 *Ibid.*; "Update: Poland shale gas licensing scandal." *Natural Gas Europe*. January 17, 2012.
- 153 Blaine (December 2011).

- 154 “Fracking stirs controversy in South Africa.” *The Guardian*. September 2, 2011.
- 155 Shell. “The Karoo Basin.” Retrieved November 14, 2011 from http://www.shell.com/home/content/zaf/aboutshell/shell_businesses/e_and_p/karoo/karoo.html.
- 156 Agbroko, Ruona. “S. Africa imposes ‘fracking’ moratorium in Karoo.” *Reuters*. April 21, 2011; Urbina, Ian. “Hunt for gas hits fragile soil, and South Africans fear risks.” *New York Times*. December 30, 2011.
- 157 Beckwith, Robin. “Shale Gas: Promising Prospects Worldwide.” *Journal of Petroleum Technology, Special Section, Shale*. July 2011 at 40; Agbroko (2011); Republic of South Africa. [Media release]. “Statement on the Cabinet meeting held on 20 April 2011.” April 21, 2012.
- 158 Blaine, Sue. “Economic benefit of Karoo shale gas ‘worth looking into’.” *Business Day* (South Africa). November 14, 2011; “Six month moratorium on Karoo fracking.” *The Independent Online* (South Africa). August 21, 2011.
- 159 National Planning Commission. “National Development Plan, Vision for 2030.” ISBN: 978-0-621-40475-3 RP270/2011. November 11, 2011.
- 160 *Ibid.* at 31.
- 161 *Ibid.*
- 162 *Ibid.* at 143.
- 163 *Ibid.*
- 164 Pétron et al. (2012); Wigley (2011) at 607; Howarth et al. (2011) at 679.
- 165 Zhang, Yue. Analyst, International Market & Strategy Analysis Group. “The Shale Gas Boom Shift to China.” *Institute of Electrical Engineers Japan*. June 2010 at 2; “China sets ambitious shale gas output targets-paper.” *Reuters*. October 12, 2011.
- 166 Bergin, Tom. “China shale gas boom could surpass U.S.-Sinopec.” *Reuters*. December 7, 2011.
- 167 Hart, Melanie and Daniel J. Weiss. Center for American Progress. “Making Fracking Safe in the East and West. Environmental Safeguards on Shale Gas Production Needed as China Begins Development.” October 2011 at 4.
- 168 *Ibid.*; Hook (2011).
- 169 Reed and Roberts (2011); Hart and Weiss (2011) at 4.
- 170 *Ibid.* at 4 and 5.
- 171 Kirkland, Joel. “China begins to tap its shale gas, despite daunting technological, environmental hurdles.” *New York Times*. October 14, 2011.
- 172 *Ibid.*
- 173 He, Gang. World Resources Institute. “China’s new Ministry of Environmental Protection begins to bark, but still lacks in bite.” July 17, 2008; Hart and Weiss (2011) at 6, 7 and 12.
- 174 Fortunati, Roberto A. and Monica C. Lappas. “Chapter 4: Argentina.” In *Global Legal Group* (2011) at 20.
- 175 Advanced Resources International, Inc. (2011) at 1-5.
- 176 Webber, Jude. “Argentina poised for shale oil and gas boom.” *Financial Times*. December 12, 2011; Dar (2011) at 1; Advanced Resources International, Inc. (2011) at IV-22.
- 177 *Ibid.*
- 178 Krauss, Clifford. “Argentina hopes for a big payoff in its shale oil field discovery.” *New York Times*. July 4, 2011.
- 179 *Ibid.*; Beckwith (2011) at 39.
- 180 Government of the Province of Neuquén. “About Neuquén Geography.” 2012.
- 181 Wilson, Alexander. “Production in Argentina raises demand for water.” *Associated Press*. September 30, 2011.
- 182 Economic Commission for Latin America and the Caribbean. “Neuquén Province, Argentina. Basic socio-demographic profile.” 2009 at 9.
- 183 Flavin and Lenssen (1994) at 91 and 92; Energy Modeling Forum (2003) at 1; Podesta and Wirth (2009) at 1; Jaffe (2010).
- 184 “Crews stop flow of drilling fluid from Pennsylvania well.” *Associated Press*. April 22, 2011; Aaron, Jeffrey. “Pa. fracking blowout spews fluid onto state forest lands.” *Star-Gazette* (Elmira, New York). January 25, 2011; Warco, Kathie O. “Fracking truck runs off road; contents spill.” *Observer-Reporter* (Washington and Greene Counties, Pennsylvania). October 21, 2010; “Waste from Marcellus shale drilling in Cross Creek Park kills fish.” *Pittsburgh Post-Gazette*. June 5, 2009.
- 185 “Tests: Pa. gas drilling town’s water still fouled.” *The Wall Street Journal*. October 15, 2011.
- 186 Urbina (August 2011).
- 187 Wolf Eagle Environmental. “Town of DISH, Texas Ambient Air Monitoring Analysis: Final Report.” September 15, 2009 at 6; Gruver, Mead. “Wyoming is beset by a big-city problem: Smog.” *Associated Press*. March 8, 2011.
- 188 Crompton, Janice. “Residents reported gas odors before explosion.” *Pittsburgh Post-Gazette*. April 1, 2010.
- 189 Pétron et al. (2012); Wigley (2011) at 607; Howarth et al. (2011) at 679; Tyndall Centre for Climate Change Research (2011) at 6.
- 190 United Nations Commission on Sustainable Development. “Framing Sustainable Development. The Brundtland Report – 20 Years On.” April 2007.

Food & Water Watch

National Office

1616 P St. NW, Suite 300

Washington, DC 20036

tel: (202) 683-2500

fax: (202) 683-2501

info@fwwatch.org

www.foodandwaterwatch.org

