

HEALTH IMPACTS OF SHALE GAS EXTRACTION AND PRODUCTION

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Completed health studies, both in the peer-reviewed literature and those initiated or reported by grassroots groups and the press, indicate that significant negative health impacts occur near gas exploration and production activities. Emerging health studies, such as the University of Pennsylvania research*

<http://green.blogs.nytimes.com/2013/01/21/taking-a-harder-look-at-fracking-and-health/>, and others

[http://www.cectoxic.org/Final Summary Report of PH Summit 11 9 13 6 .pdf](http://www.cectoxic.org/Final_Summary_Report_of_PH_Summit_11_9_13_6_.pdf) will soon give a clearer picture. Most importantly, there are many people who have already been impacted in states where unconventional gas extraction is permitted. These cases should be documented and pathways of exposure and contamination determined. This scientific information is fundamental to making informed decisions about the process. As we review the studies already completed, and speak with impacted people, we are increasingly aware that there are impacts on health that have not been addressed, and pathways of exposure that have not been assessed. That includes not just the water pathway, but also the air and dermal pathways.

*Three major studies (UPenn, NIEHS and other partners; UPenn's Environmental Health Sciences Core Center-EHSCC- is funded by the NIEHS and has taken the initiative to form an inter-Center working group comprising 10 of the 17 existing EHSCCs to pool resources and conduct research on the potential health impacts of unconventional gas drilling) on health are underway:

Study [1] 'Field Survey of Health Perception and Complaints of PA Residents in the Marcellus Shale' led by Dr. Pouna Saberi-Funded by UPenn-EHSCC, and will be published shortly;
Study [2] An inter-Center Pilot Project: "Groundwater Quality and health Outcomes in Adjacent Areas With and Without Hydrofracturing Activities" funded by Columbia EHSCC and UPenn EHSCC, with results in a year or two;

Study [3] An inter-Center Pilot Project: "Harvard WorldMap: Fracking Research Repository for All Concerned (HWM: FRRAC)" funded by Harvard EHSCC and UPenn .

--Study [1] is being prepared for publication and studies [2] and [3] have received funding, and in progress.--

HEALTH IMPACTS FROM GAS DRILLING AND RELATED ACTIVITIES ARE DUE TO EXPOSURES TO TOXINS VIA CONTAMINATED AIR AND WATER, AND SOMETIMES FROM A COMBINATION OF THE TWO. COMMUNITY IMPACTS ARE ADDITIONAL STRESSORS WHICH IMPACT HEALTH.

DETERMINANTS OF HEALTH

Health is determined by many factors or influences, including age, sex and constitutional or genetic factors, plus availability of medical care. These in turn are influenced by individual behaviors which are shaped by the conditions and opportunities in the community and in the home. And these factors are in turn influenced by another umbrella of socio-economic, cultural and environmental conditions <http://jech.bmj.com/content/64/4/284.full>.

PEER REVIEWED LITERATURE and MEDICAL OBSERVATIONS

Elaine Hill is documenting how proximity to gas wells affects birth weight, and she is finding that it does, and it is a negative impact, probably due to air pollution <http://ourhealthandenvironment.wordpress.com/2012/07/21/fracking-and-low-birth-weight-preliminary-evidence/>

Medical colleagues in Utah are dealing with unprecedented levels of dangerous air pollution from industrial sources, much of it gas drilling and distribution-related, estimating billions of dollars of additional healthcare costs due to exposure to ozone, PAHs, endocrine disruptors and other chemicals. (personal communication, Utah Physicians for a Healthy Environment, wrote that the costs of air pollution in Utah, pop. 3 million, are already \$10 to 12 Billion; and Dr Kirtley Jones comments on health impacts of air pollution on babies <http://environews.tv/dr-kirtly-jones-reveals-the-damage-caused-to-fetuses-and-young-children-by-elevated-air-pollution/>).

Early results from an on-the-ground assessment from the Southwest Pennsylvania Environmental Health Project (SWPA-EHP) indicate that environmental contamination is occurring near natural gas drilling sites and is the likely cause of associated illnesses. http://sites.nationalacademies.org/dbasse/beccs/dbasse_083187#.UcRaEVPaiLw (see David Brown's presentation and also that of John Adgate).

These early results from the SWPA-EHP study implicate air contamination as the likely cause of three-quarters of the associated illnesses documented by them. In some cases, significantly elevated levels of fracking-related air pollutants were found in the air inside of people's homes.

This is an unacceptable problem: breathing is mandatory and, while a drinking water source might be replaced, air cannot.

A minority of cases suffered from likely exposures to tainted water, but these low numbers are not reassuring. Water contamination often takes a while to appear. Well casings continue to fail as they age — up to 60 percent over 30 years — and, as they do, we expect health effects from waterborne contaminants to rise and spread to more communities.

The papers on the health impacts near gas drilling operations include the work of Michelle Bamberger and Robert Oswald who documented several cases where chemicals associated with drilling were implicated in negative health outcomes in animals and people.

http://www.psehealthyenergy.org/Impacts_of_Gas_Drilling_on_Human_and_Animal_Health

One of the several cases they describe was the death of 17 cows within one hour from direct exposure to hydraulic fracturing fluid. The final necropsy report listed the most likely cause of death as respiratory failure with circulatory collapse. The hydraulic fracturing fluid that they drank contained petroleum hydro-carbons plus other toxins.

Another case documented was the death of companion animals with gas operations nearby—and road-spreading of waste was implicated.

Two cases provided unplanned but inadvertent control experiments—another standard in research-- since herds of cows were kept in different pastures. The cows that drank contaminated water had a high death rate, and a high rate of stillborn and deformed calves.

In one of the homes, a child became ill with fatigue, confusion, abdominal and back pain. After several animals in the household had died, the doctor became suspicious of toxins and testing revealed arsenic in the child. The family then stopped drinking the water despite results which showed the well water was safe and he eventually recovered, having lost a year of school. In these cases, there were 25 wells within two miles of the homes, and there was also the aerated impoundment, and two compressor stations within a mile. While checking for other toxins in these two homes, random urine tests on family members revealed phenol, a metabolite of benzene; symptoms observed by families in both homes included extreme fatigue, headaches, nosebleeds, rashes, and sensory deficits (smell and hearing). Were it not for the deaths of the animals, the human health effects would not have been found.

Their study illustrates several plausible links between gas drilling and negative health effects.

Drs Bamberger and Oswald are the guest editors of an entire edition of a journal called New Solutions, and it is dedicated to impacts of gas drilling.

Given that exposures and illness increase over time and given that many instances of contamination and illness related to fracking never come to light due to non-disclosure agreements with the industry, we cannot accurately quantify the extent of the problems with gas drilling <http://concernedhealthny.org/category/press-releases/>.

In the next section some of the individual stressors are listed, together with supporting literature. Please see more references at the end of these comments.

www.concernedhealthny.org and www.psehealthyenergy.org list additional and updated peer-reviewed articles, reports and testimonies from health professionals.

THERE ARE STRESSORS ON HEALTH FROM SHALE GAS EXTRACTION WHICH CANNOT BE ELIMINATED WITH CURRENT TECHNOLOGY BECAUSE IT DOES NOT EXIST YET, OR BECAUSE THEY ARE TOO EXPENSIVE TO MITIGATE, OR BECAUSE FEDERAL AND STATE LAWS ARE LAX. THIS INCLUDES:

--ABANDONED WELLS -- all wells will eventually leak since casings and cement are man-made and will not withstand decades of high-pressure and corrosive materials. Abandoned wells include ignored wells; it would be extremely costly to identify and plug all of them, and the locations of many are unmapped. 6-9% of casings fail immediately.

- http://www.psehealthyenergy.org/data/PSE_Cement_Failure_Causes_and_Rate_Analysis_Jan_2013_Ingraffea1.pdf
- http://www.damascuscitizensforsustainability.org/wp-content/uploads/2012/06/theskyispink_annotdoc-gasl4final.pdf

--FLARING --releases chemicals, creates particulates and causes symptoms (observed by health professionals); at issue are the unknown chemicals, exemptions, and the fact that the technology does not exist for alternatives.

--DIESEL EXHAUST --from trucks, compressors, processing plants; no cumulative impacts have been considered, yet it is clear that there are health impacts from these emitters; modeling has shown that impacts may be experienced at six miles; diesel exhaust is now considered a definite carcinogen. And since the World Health Organization has now classified diesel exhaust as a definite carcinogen, it raises additional concerns for workers and other vulnerable groups exposed to diesel exhaust.

--WATER CONTAMINATION --residents have barium, arsenic, VOCs, methane, radionuclides and other toxins in their water wells claimed to be a result of drilling nearby, and which is denied by industry; here are recent papers:

- Methane migration—2011 Duke study
<http://www.biology.duke.edu/jackson/pnas2011.html>
- Brine migration--2012 Duke and CalStatePolytech
<http://www.pnas.org/content/early/2012/07/03/1121181109.full.pdf>
- Increased stray gas abundance in water wells near Marcellus shale gas wells—2013 Duke, U of Rochester, CalStatePolytech and Max Planck Institute
<http://www.pnas.org/content/110/28/11250.full.pdf>

- Increased total dissolved solids and heavy metals in groundwater near Texas gas drilling sites--2013 Univ of Texas <http://pubs.acs.org/doi/pdf/10.1021/es4011724>
- Bamberger and Oswald—2012 New Solutions http://www.psehealthyenergy.org/Impacts_of_Gas_Drilling_on_Human_and_Animal_Health
- Amy Mall—NRDC 2011-12 http://switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html

--AIR POLLUTION --has been shown to be associated with neurodevelopmental disorders, lower IQ in babies born to mothers with polycyclic aromatic hydrocarbon exposure during pregnancy, and learning disorders in exposed children. (see references at end of paper).

The American Academy of Pediatrics notes that children are especially vulnerable because their lungs continue to grow and enlarge until about age 18. Plus children breathe faster and are closer to the ground. As they mature in the presence of ozone, alveolar production is reduced, and the result of chronic ozone exposure can be brittle lungs like those of an elderly adult.

Silica is the sand that is used in hydraulic fracturing. It is mined in Minnesota and Wisconsin and is not regulated as a hazardous pollutant by the U.S. Environmental Protection Agency. NIOSH has identified exposure to crystalline silica during hydraulic fracturing as the most significant known health hazard to workers. It is also a hazard to the workers in the Midwest mining it and to the residents living nearby.

Inhalation of fine dusts of crystalline silica can cause silicosis which is an incurable lung disease. It's also been determined to be a lung carcinogen.

Here are some recent papers:

- Perera at Columbia reports on air pollution and cancer risk <http://ccceh.hs.columbia.edu/pdf-papers/PereraCEBP2011.pdf>
- Wilhelm at UCLA reports on air pollution and premature births. <http://www.environment.ucla.edu/reportcard/article.asp?parentid=1700>
- Air pollution tied to stroke and cognitive decline, from Medpage review of two peer-reviewed articles, February 2012. http://www.medpagetoday.com/Cardiology/Strokes/31158?utm_content=&utm_medium=email&utm_campaign=DailyHeadlines&utm_source=WC&eun=g438876d0r&user_id=438876&email=lar917dy@gmail.com&mu_id=
- Witter R, et al, Battlement Mesa HIA 2011 <http://www.garfield-county.com/environmental-health/battlement-mesa-health-impact-assessment-draft2.aspx>
- McKenzie LM, et al, Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources 2012 <http://www.ncbi.nlm.nih.gov/pubmed/22444058>

- Colborn T, et al, An Exploratory Study of Air Quality near Natural Gas Operations 2012 <http://www.endocrinedisruption.com/chemicals.air.php>
- NOAA ozone study <http://www.eenews.net/public/Landletter/2011/04/21/1>
- Simpson I et al, Air quality in the Industrial Heartland of Alberta, Canada and potential impacts on human health 2013 <http://concernedhealthny.org/wp-content/uploads/2013/07/Simpson2013-AE-in-press.pdf>

--ACCIDENTS—happen, even with best management practices and regulations

http://democrats.naturalresources.house.gov/sites/democrats.naturalresources.house.gov/files/2012-02-08_RPT_DrillingDysfunction.pdf.

--CHEMICALS –include both introduced and those from down-hole; federal exemptions limit information; observed symptoms include respiratory, cardiovascular and/or neurologic problems; interaction of chemicals with other chemicals and with naturally-occurring substances have not been studied (limited by NDAs, lack of funding and federal exemptions). A large percentage (about 40% according to Dr Theo Colborn) are ENDOCRINE-DISRUPTING CHEMICALS (EDCs)– which impact children and the unborn disproportionately.

- proprietary classification of chemicals hampers health studies
- includes known or suspected carcinogens, mutagens, endocrine disruptors, neurotoxins, hazardous air pollutants [Natural Gas Operations from a Public Health Perspective](#)
Theo Colborn, Carol Kwiatkowski, Kim Schultz, Mary Bachran
[Human and Ecological Risk Assessment: An International Journal](#) Vol. 17, Iss. 5, 2011
- many of the chemicals in these products have effects at low doses
<http://edrv.endojournals.org/content/early/2012/03/14/er.2011-1050.full.pdf#page=1&view=FitH>
- pathways have not been identified for illness near gas drilling sites, Oswald and Bamberger
http://www.psehealthyenergy.org/Impacts_of_Gas_Drilling_on_Human_and_Animal_Health

--FOOD CHAIN CONTAMINATION –animals are sentinels; soil farming with gas well waste occurs with some regularity, as does road spreading.

The toxic chemicals are classified as secret, or proprietary, which hampers health studies, but we know it includes known or suspected carcinogens, mutagens, neurotoxins, hazardous air pollutants, and endocrine disruptors which have effects at very low doses (Colborn).

--COMMUNITY IMPACTS – Besides the environment, community well-being is another major determinant of health.

In areas where the drilling has occurred it has splintered the residents into the minority who benefit financially-- like those who have leased large acreages, some businesses like motels and

diners, those who get jobs in the industry, drug traffickers, and politicians who are given money for their campaigns. But those who lose are the majority—homeowners who have lost their water, air, the value of their homes and their health. The stress of not knowing if and when that loss will occur is also significant, and research provides evidence that such stress can negatively impact a person’s health. People already under stress from an underlying illness, or poor socioeconomic status, or because they are simply very young or very old and therefore a vulnerable population, suffer environmental and societal impacts less well than people who are not so stressed.

There is also the potential loss of traditional, sustainable jobs, such as in tourism and farming which could be displaced when a high impact industry such as gas extraction moves into a region.

Crime and sexually transmitted diseases are increased with the influx of gas workers “Public Health Risks of Shale Gas Development” by John L. Adgate, Bernard Goldstein, and Lisa M. McKenzie

http://sites.nationalacademies.org/xpedito/groups/dbassesite/documents/webpage/dbasse_083235.pdf, and health infrastructure is taxed

<http://www.damascuscitizensforsustainability.org/wpcontent/uploads/2012/01/stateimpactpa-troy-community-hospital-report.pdf>.

There are cumulative effects of multiple stressors, Clougherty 2009

<http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.0900612>.

And Dr Roxana Witter notes that additional research on community impacts is needed

<http://www.iom.edu/Reports/2013/Health-Impact-Assessment-of-Shale-Gas-Extraction.aspx>.

--VULNERABLE POPULATIONS AND SOCIAL JUSTICE – this extractive industry not only impacts vulnerable populations in a disproportionate way, it also creates vulnerable groups, eg, sick workers, small-for-gestational-age babies, etc .

Section 2.2 of the EPA document entitled, *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources: PROGRESS REPORT* <http://epa.gov/hfstudy/pdfs/hf-report20121214.pdf> addresses environmental justice. I was surprised and dismayed that with all of EPA’s resources, the EPA was unable to determine the impact on vulnerable groups. States maintain location data for all permits and wells drilled, so it is not necessary to depend on company information or FracFocus, another industry-related enterprise. EPA could also have looked to the data compiled by FrackTracker Alliance, a non-governmental organization <http://www.fracktracker.org/>. There you will find the waste treatment facilities, and for some states, the water withdrawal locations. River Basin Commissions have accurate data on water withdrawals, so if your study area is part of such a river basin commission, that data on water withdrawals is available. The EPA should also be familiar with the County Health Rankings, a

project of the University of Wisconsin and Robert Wood Johnson Foundation <http://www.countyhealthrankings.org/>, with annual data reported. Although specific communities are not identified or ranked in this system, at the very least the EPA would be able to begin looking at the counties with poor health outcomes and concentration of wells. Addressing vulnerable population needs and environmental justice concerns should be a priority in any federal study.

--WORKER HEALTH -- these workers are part of the community and their ill-health taxes the family and the community, and eventually the state.

- <http://www.cdc.gov/niosh/docket/review/docket213/pdfs/OilGasExtractionDraftAug2010.pdf>
- <http://www.southernstudies.org/2012/05/institute-index-frackings-dangers-for-workers.html>
- <http://www.iom.edu/Reports/2013/Health-Impact-Assessment-of-Shale-Gas-Extraction.aspx>

--SILICA USE – highly toxic to workers and community where it is mined, stored and used http://www.osha.gov/dts/hazardalerts/hydraulic_frac_hazard_alert.html.

--ECONOMIC IMPACTS –few years of prosperity for some (but there will be inequity), and then there will be a bust (documented).

--HUMAN ECOLOGY--

- Vulnerable populations are created but not protected
- Economics impact human health
- Food chain contamination will eventually impact humans
- Occupational safety --the on-the-job fatality rate of oil and gas workers is eight times higher than the rate for all U.S. workers, as reported by the Centers for Disease Control.

--NOISE POLLUTION --EU study links noise to CV and neurologic ill health

- http://www.euro.who.int/_data/assets/pdf_file/0008/136466/e94888.pdf

--PATHWAYS OF EXPOSURE exist but their identification is limited by non-disclosure agreements (NDAs) and federal exemptions, as well as limited funding for research;

- Source of contamination: Cement casing leaks 6-9% of wells
- Environmental media and transport mechanism: Soluble/volatile and particulate. slickwater. Drilling muds. Flowback/produced water/Waste
- Points of exposure
- Route of exposure
- Receptor population

--RADIOACTIVITY -- high radon in indoor air, gas and in water from the Marcellus shale area already exists, as does elevated radium.

- <http://pubs.usgs.gov/of/2009/1257/pdf/ofr20091257.pdf>
- http://pubs.usgs.gov/of/2012/1150/pdf/ofr2012-1150_report_508.pdf
- <http://pubs.usgs.gov/sir/2011/5135/pdf/sir2011-5135.pdf>
- A federal exemption to the Resource Conservation and Recovery Act allows anything that has come from down hole to be exempt from hazardous classification.
- <http://www.epa.gov/radon/pubs/citguide.html>
- Reference from the NAS on health impacts of radon exposure
http://www.nap.edu/openbook.php?record_id=5499&page=R11
- A short report from an industry publication, the Oil and Gas Journal, 1990,
<http://www.ogj.com/articles/print/volume-88/issue-26/in-this-issue/production/radioactive-materials-could-pose-problems-for-the-gas-industry.html> -- recognizing that radioactivity could pose problems.
- A. Paschoa and F. Steinhäusler, Technologically Enhanced Natural Radiation, in: ELSEVIER, [Radioactivity in the Environment, Volume 17](#), 2010
- The recommendations from the IAEA of which the US is a member http://www-pub.iaea.org/MTCD/publications/PDF/Pub1171_web.pdf
- ICRP recommendations
<http://www.icrp.org/docs/Michael%20Cowie%20Developemetrn%20of%20a%20NORM%20Management%20Strategy%20Oil%20and%20Gas%20.pdf>

For decades we have known the Marcellus shale to be more radioactive than other shales. The radioactive elements found in Marcellus shales include uranium, thorium, radium and also radon.

Radon is the leading cause of lung cancer among non-smokers and the second leading cause among smokers, and accounts for 21,000 lung cancer deaths per year on a nationwide basis, according to the EPA. Also from the EPA, we know that areas overlying the Marcellus shale have high indoor radon, on average, already, and will be at risk if exposed to radon additionally via delivered gas which we believe will be higher in radon than is safe. The only “safe” level of radon is “0 picoCuries/L”. No environmental or health agency is tracking the radioactive exposure at the well site (radon and radium), in pipelines (radon, radium, lead, polonium) or at end use—people’s homes (radon).

The press has exposed industry practices such as dangerous disposal of radioactive waste (NYTimes). A federal exemption to the Resource Conservation and Recovery Act allows anything that has come from down hole to be exempt from hazardous classification. So this waste, including radioactive drill cuttings and sludge, can be spread on roads, buried on site, released into streams or sent to town dumps or POTWs which can leach into drinking water. And there’s the underground injection of toxins which then contaminate drinking water which Propublica has exposed.

The radon content in gas drilling areas, including accumulation in homes near gas drilling operations will increase as more wells are drilled:

- <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3621574/> Australian study--point was to predict GHG emissions using radon as a tracer; where there's shale or coal seam gas, there's radon
- <http://www.iasj.net/iasj?func=fulltext&aId=56718> 2010 O&G article
- <http://www.bioline.org.br/request?ja13031> 2013 Radiological impact O&G Niger Delta

--STRESS – leads to depression and other mental health issues; there are cumulative effects of multiple stressors, Clougherty 2009

<http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.0900612>

--WASTE – NY and Ohio are receiving toxic waste from PA, and this process is inadequately controlled; there is no place to safely put the waste due to radioactivity, heavy metals, TDS, VOCs; road spreading and soil farming are unacceptable. The waste:

- is hazardous with current disposal methods
http://www.shalegas.energy.gov/resources/060211_earthworks_petroleumexemptions.pdf and <http://www.dcbureau.org/201308148881/natural-resources-news-service/new-york-imports-pennsylvanias-radioactive-fracking-waste-despite-falsified-water-tests.html#more-8881>
- contains radioactive elements, brine and gases
<http://www.grassrootsinfo.org/pdf/radioactivewaste.pdf> and <http://www.grassrootsinfo.org/pdf/whitereport.pdf>
- is exempt from federal oversight
<http://www.epa.gov/osw/nonhaz/industrial/special/oil/oil-gas.pdf>
- disposal in underground injection wells can, and has caused earthquakes, *Katie M. Keranen, Heather M. Savage, and Geoffrey A. Abers et al., "Potentially Induced Earthquakes in Oklahoma, USA: Links between Wastewater Injection and the 2011 Mw 5.7 Earthquake Sequence," Geology, vol. 41, no. 3 (March 26, 2013)*
<http://geology.gsapubs.org/content/early/2013/03/26/G34045.1.abstract>
<http://www.ideo.columbia.edu/news-events/wastewater-injection-spurred-biggest-earthquake-yet-says-study> <http://stateimpact.npr.org/texas/tag/earthquake/>
- Dr Conrad Volz Senate testimony
<http://www.chec.pitt.edu/documents/Testimonies/Volz2011senatetestimony.pdf>
- <http://www.nytimes.com/2012/05/04/nyregion/wastewater-is-an-issue-in-hydrofracking.html>
- http://www.ean-norm.net/lenya/ean_norm/images/pdf/IAEA_Activities_NORM_Proehl.pdf ICRP and IAEA overview of management of radioactive waste in the oil and gas industry

--CLIMATE CHANGE-- Recent climate events have served to convince our lawmakers that climate change is real. Recently, a paper was published whose authors from Stanford, Cornell and Physicians, Scientists and Engineers for Healthy Energy demonstrate how NY State can be

fueled mostly by renewables by 2030, and fully by 2050. The same could be true for other states.
<http://www.psehealthyenergy.org/site/view/1083>

Methane is the second largest contributor to human-caused climate change, after carbon dioxide. Natural gas systems are the single largest source of anthropogenic methane emissions in the U.S., representing almost 40% of total emissions (EPA 2011 data)

http://www.psehealthyenergy.org/data/PSE_ClimateImpactsSummary_ALLCitations_01Feb2013.pdf

- 2009 Sheffield and Landrigan. Global climate change costs significant healthcare dollars “Global Climate Change and Children’s Health: Threats and Strategies for Prevention”
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059989/>
- 2009 Shindell. Methane is a potent greenhouse gas, 33 times more efficient at trapping heat than carbon dioxide over 100 years, and about 100 times more potent than carbon dioxide over 20 years. Shindell et al, Improved attribution of climate forcing to emissions, Science.
- 2011 Howarth, Santoro and Ingraffea. “The footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly so over 20 years.” <http://link.springer.com/article/10.1007%2Fs10584-011-0061-5>
- 2012 Tollefson. In an area known as the Denver-Julesburg Basin, where gas drilling is the prominent industry, they are losing about 4% of their gas to the atmosphere — not including additional losses in the pipeline and distribution system.
http://www.nature.com/polopoly_fs/1.9982!/menu/main/topColumns/topLeftColumn/pdf/482139a.pdf
- 2012 Howarth. While methane is only causing about 1/5 of the century-scale warming due to US emissions, it is responsible for nearly half the warming impact of current US emissions over the next 20 years.
http://www.eeb.cornell.edu/howarth/publications/Howarth_et_al_2012_National_Climate_Assessment.pdf
- 2012 Myhrvold, N. P. and K Caldeira. The carbon dioxide emitted from burning natural gas contributes significantly to greenhouse gas emissions driving global climate change.
http://iopscience.iop.org/1748-9326/7/1/014019/pdf/1748-9326_7_1_014019.pdf
- 2013 NOAA and CIRES. An emission rate corresponding to 6.2-11.7% of average hourly natural gas production in Uintah County was measured in the month of February.
<http://onlinelibrary.wiley.com/doi/10.1002/grl.50811/abstract>

COMPREHENSIVE HEALTH STUDIES ARE VITAL, YET THEY ARE NOT KEEPING PACE WITH THE RAPID DEVELOPMENT OF THIS INDUSTRY

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3237379/>

In 2005, Congress passed the Energy Policy Act, which, in effect, exempted the oil and gas industry from key provisions of the most important environmental and public health laws, such as the SDWA, CAA, CWA, RCRA, NEPA, CERCLA aka Superfund, and others. The federal exemptions were passed seven years ago (Highlights of Oil and Gas Industry Exemptions from Federal Statutes http://www.citizenscampaign.org/PDFs/cce_hvhf_wp_final.pdf), <http://www.ewg.org/reports/Free-Pass-for-Oil-and-Gas/Oil-and-Gas-Industry-Exemptions>, <http://www.nrdc.org/land/use/down/fdown.pdf> and during that time the oil&gas industry has been overseen less than optimally. So we do not know the immensity or the extent to which health or environmental impacts have occurred, though we know that people in close proximity to oil and gas exploration and production activities perceive that they have been negatively impacted, and there is medical confirmation that this is, in fact, true.

Other reasons for the paucity of scientific information:

--Most of the peer-reviewed literature on health impacts has been published only in the last 1-2 years, M. L. Finkel and A. Law, "The Rush to Drill for Natural Gas: A Public Health Cautionary Tale," *American Journal of Public Health* 101(5) (2011): 784-5, doi: AJP.2010.300089 [pii] 10.2105/AJP.2010.300089 <http://www.ncbi.nlm.nih.gov/pubmed/21421959>

--Research funding has been limited.

--State and federal regulations vary but so far have not included health literature, doctors and public health professionals, Bernard Goldstein et al "Missing from the Table: Role of the Environmental Public Health Community in Governmental Advisory Commissions Related to Marcellus Shale Drilling" http://www.psehealthyenergy.org/data/NIEHS_-_missing_from_the_table_jan_2012.pdf

--Non-disclosure agreements hamper access to important information. <http://www.post-gazette.com/stories/business/legal/washington-county-judge-orders-marcellus-shale-development-settlement-records-unsealed-680087/?print=1>

Another obstacle has recently emerged in certain states, and that is limiting the information that doctors can share if they receive vital chemical information from industry in order to treat their patients. In Pennsylvania and Colorado, doctors are required to sign a non-disclosure agreement in exchange for life-saving information.

<http://www.motherjones.com/environment/2012/03/fracking-doctors-gag-pennsylvania> and http://www.denverpost.com/environment/ci_22827696/colorado-docs-chafe-at-secrecy-oath-needed-access#ixzz2O658UecK

There are non-governmental organizations engaging in research: Earthworks just published a paper

http://www.earthworksaction.org/media/detail/new_research_links_health_problems_with_oil_and_natural_gas_development#.Uob24BqsiSo on a survey done in Pennsylvania which demonstrates negative health impacts close to wells. Amy Mall of NRDC has a list of hundreds

of cases of water contamination

http://switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html ; Damascus Citizens for Sustainability is doing baseline methane monitoring in select localities <http://www.damascuscitizensforsustainability.org/2012/11/damascus-baseline/> and <http://www.damascuscitizensforsustainability.org/dep-data-for-dimock-pa/> and other towns.

There is a process which brings public health to the table and which can inform land use decisions and should be used prior to the development of regulations and before permitting. It is particularly important in the case of gas exploration and production, and should be undertaken at the national level.

“HIA is a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population. HIA provides recommendations on monitoring and managing those effects;” from “Improving Health in the United States: The Role of Health Impact Assessment” http://www.nap.edu/catalog.php?record_id=13229

An HIA would add value to the policy decision because it would include:

- the current health literature and be inclusive of future research
- the medical profession
- possible exposure pathways, even if remote
- direct and indirect impacts on all the determinants of human health
- consideration of all population groups—the vulnerable, workers and community units, and stakeholders
- recommendations which would improve health outcomes
- a plan for monitoring and evaluation

Important characteristics of an HIA:

- It is meant to be prospective, preventive and proactive
- The timing of an HIA is best when it is done before a policy, process or regulation is implemented
- It focuses the attention of decision-makers on the health consequences of projects and policies that they are considering
- It identifies vulnerable groups and stakeholders
- An HIA uses existing data sources such as population data, surveys, risk assessment, literature review, expert opinions and stakeholder input to predict the impact on a population from a particular land use decision by considering direct and indirect health risks and solutions from a cradle-to-grave approach
- It is a decision support tool and not intended to simply evaluate a decision after it is made

- It offers recommendations for further study, and does not necessarily include all the studies; it draws from available information in similar conditions when data is incomplete
- It has the potential to save healthcare costs in the long run.

IMPACTED PEOPLE

People near gas drilling sites in Pennsylvania, Colorado, Texas and other states have had a rash of unexplained illnesses, sick and dying pets and livestock, contaminated drinking water, unacceptably high ozone in areas that were known previously for their pristine air quality, lost homes and shattered communities.

I have spoken with impacted families who have become ill since their air or drinking water became contaminated after a gas well was drilled near their home, or compressor stations erected nearby. These people have skin lesions, respiratory issues, headaches and other neurological problems.

I have also spoken with a woman in Erie Colorado whose family has had exacerbations of asthma and recently they've begun experiencing neurological problems; Erie CO has many gas wells and compressors http://www.denverpost.com/business/ci_20553795/colorado-join-studies-air-quality-around-oil-and .

Last year I travelled to Paradise Road in Wyalusing, Bradford County to speak with a group of people who had leased and who already had contaminated water--many of the homes on Paradise Road had visible water buffaloes. Of note, these people had never spoken with a doctor about their water contamination and the possible health implications. The couple hosting this gathering was expecting a baby... A few months later we learned that the baby was born with a cardiac defect. Chance? Perhaps...but maybe not...and no registry exists in Pennsylvania that includes surveillance of health impacts or monitoring of impacted people as they would relate to gas wells and infrastructure.

Recently I have spoken with two families. These are their stories:

The first family was well, living modestly on family-owned land which sits in a hollow, until 2008. The children were average to very good students, with excellent attendance records.

Although rural, this area was a coal mining region.

In 2005 an electric compressor was placed on the hill above their home, about 500-700 ft away.

In 2008 two gas compressors joined the first one on the hill. Also in 2008 five gas wells were spudded and completed on another hilltop, less than one-half mile away from the house, plus a glycol dehydrator and a sludge tank.

Around the end of 2008, and early 2009, the mother and grandmother began observing changes, subtle at first, in the children, as well as in them.

Over the course of the years since 2008/2009, there have been odor events noted numerous times. The odors have been chlorine-like, and at other times sweet-smelling. These occur almost every day. It may be preceded by a vapor mist, which appears to have tiny bubbles, that comes downhill from the compressors. On occasion there are what the family would characterize as extremely odorous events, where it is difficult to breathe. Significant health impacts occur right after such events.

One of the twin sons, who was an average student with perfect attendance, developed headaches, rashes and behavior changes, beginning in 2008/2009. These were minor at first, but have worsened. He began missing school and was more difficult to manage. In 2012 he began having involuntary movements that appeared tic-like, tremulousness on occasion, shaking hands and seemed to lack coordination. He had a neurological work-up and is under the care of a neurologist who prescribed an anti-seizure medication. He has recently been evaluated by the Individualized Education Program (IEP) team at school because of poor performance.

The other twin has had a similar course as his brother. He also developed abnormal movements a short while later than the first twin, and he is also being treated with the anti-seizure drug. After having been an honors student, he is also now undergoing an IEP evaluation. The twins currently weigh about 90 lbs, and have had very little weight gain in two years.

One twin more than the other has been behaving bizarrely and dangerously. A neuropsychiatric examination is scheduled for both.

A 13 yo son suffers from severe headaches for which he is medicated, and he has lost days of school. Since last week he has also had abnormal movements and just had an EEG and he was also started on the anti-seizure meds. He is also very sensitive to noise; his room faces the compressors and therefore receives the most noise. When the compressors are running, which is most of the time, the family describes the noise as similar to ten trains. The blowdowns occur without notice.

An 18 yo daughter began having behavior problems and slowed speech at age 16. An evaluation by the neurologist included an EEG and MRI, and revealed that she had had a stroke.

A 20 yo daughter and not living in the house for the past year, but lives not far and visits, has had headaches, abnormal hand movements, leg pain and memory problems.

The mother was also previously healthy. Over the past few years she has had gastrointestinal problems (improved when she stopped drinking the water) and has lost about 50 lbs. In 2010 she noted a very strong chlorine-like smell which “took her breath away” and to which she was exposed for about 2 to 3 minutes. She felt ill immediately and shortly thereafter developed congestion, and blisters in her nose, on her neck, face and arms (exposed skin areas). About three months later, because she was pale and had continued blistering of the mucous membranes, particularly the nasal mucosa, she returned to the hospital. Following an evaluation, the health professionals recommended that the family evacuate the house and also a Hazmat team visit, but none appeared. The mother has also seen the neurologist for weakness, memory problems, trembling hands and a feeling described as “bugs crawling on the skin”. She has been diagnosed with polyneuropathy and is on medication.

The grandmother has hypertension and tachycardia, and is on medication for these conditions.

In 2010 the mother and grandmother both had blood work for environmental toxins. The grandmother had phenol, benzene, arsenic, and cadmium in her blood; the mother had phenol and benzene. The children were not tested.

All the family members have had rashes which appear occasionally, described as red, occasionally slightly raised. The family recalls one specific episode of these rashes in the children, in 2010, following another chlorine odor event.

On July 3rd of this year there was a strong sweet-smelling odor event that was followed by diffuse red rashes in the boys who had been playing outside. One boy developed a boil in the groin which improved, in time, after two rounds of antibiotics, but recently another boil developed. The other boy developed a boil and cellulitis in the axilla this past week. They never had such infections.

Additional Environmental History:

Gas wells—there are five on the opposite hill which were fracked in 2008, during which time there were two frack ponds. In 2009 a neighbor whose house overlooked the ponds noticed that a creek that runs between his house and this family’s house suddenly flooded and the water turned black in the creek. This creek is 15-20 ft from their yard.

Pets—there is a small dog owned by the grandmother who, whenever he had been outside, was seen licking his paws afterwards, and then he would vomit. The dog no longer wants to go outside, especially when the decking is moist from rain or what appears to be dew, but could be the vapors that come down the hill from the compressors (often noticed in the evenings), as they also cover the house with a moist film. The grandmother separately noticed that when she took the plant covers from her tomatoes, that covering, which often had some moisture on it, burned her hands. A calico cat started losing hair, became very aggressive and bit two of the children in 2008/9. She disappeared soon after. Another dog, a lab/boxer mix cowered at the sounds of the

compressors; he also became aggressive and eventually disappeared. In 2010 when the first compressor was placed, the family found 30 dead black birds in their backyard one day.

Five older neighbors have died in the past nine months, and this family feels that this is unusual for their small hollow. Four of the deceased had respiratory problems contributing to their deaths. There are other neighbors, both children and adults, who have health issues like nosebleeds, respiratory problems and neurological issues.

The hollow where they live has been visited by a federal agency but their case has not been further evaluated by any public health agency.

The second family works in the industry. The husband does construction work as a sub-contractor. He describes one episode where his crew was doing work and there was a blowback, a foggy material was released and covered the ground, and the accompanying spray coated his workers with a burning fluid. He had no idea what the material was, and they were not wearing any protective gear.

He has seen “too many dead cows and deer not far from gas development areas”, he says.

But the story is about his wife. About five years ago, the wife took a job painting glycol dehydrators, well heads, brine tanks and other infrastructure on working well sites and compressor stations. Immediately following one of the first jobs, as she started the drive home, she felt nauseated, developed a severe headache, a sore throat and by the time she got home she was covered in rash on all the exposed parts of her body. Eventually some of the red rash evolved into open sores. These came and went. The husband reports that she has the scars from these sores. The wife stopped going on these jobs after several of these episodes. Then, she started to have behavior changes—irritability and forgetfulness. She has now been diagnosed with dementia, and is in a doctor’s care and being medicated for that.

About four years ago she developed an excoriated area on the top of her ear, which seemed never to completely heal. At this point, the top of her ear is gone, and two days ago the lesion was biopsied for cancer.

Her case has never been reported to any public health agency.

--To help address the lack of information at the federal public health level, Damascus Citizens for Sustainability (DCS) has developed a Gas Exploration and Production survey of environmental and health impacts <http://www.damascuscitizensatsdr.org/> as a tool through which the Agency for Toxic Substances and Disease Registry will receive information about possible health impacts from gas drilling, as well as a petition for a Public Health Assessment, from households in a survey impact area.

DCS knew that: a) ATSDR was not aware of certain cases of contamination or of health impacts, unless they were specifically asked to consult; b) an agency, organization or individual can request a health consultation via the petition process (42 Code of Federal Regulations, Part 90, published in 55 Federal Register 5136, February 13, 1990) <http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html>; c) the public was not aware of this mechanism; d) the survey provides a systematic reporting to a federal public health agency, ATSDR, using a mechanism accepted by that agency--the petition process.

The goals of the survey are to:

- provide a standardized mechanism for individuals, families or communities to report health and community impacts that they attribute to shale gas extraction and production activities.
- engage the ATSDR by forwarding completed Surveys to ATSDR's Region 3. Region 3 has been designated to collect the surveys which will be sent to them from across the country.
- trigger a Public Health Assessment by the ATSDR in each geographic region where Survey submissions indicate this is warranted.
- encourage the ATSDR to aggregate the reported impacts in a federally-maintained national database.
- influence public policy regarding shale gas extraction and production activities in so far as such activities are demonstrated to adversely impact human and animal health.

DCS will help residents fill out the survey; each completed survey will be forwarded as a formal Petition for a Public Health Assessment to ATSDR.

--The List of the Harmed has over a thousand "anecdotes".

<http://pennsylvaniaallianceforcleanwaterandair.wordpress.com/the-list/>

Prominent scientists who have been at the forefront of both research and patient care recently wrote to the Albany Times Union.

In "*Assessing the risks of fracking*", Dr David Brown (SWPA-Environmental Health Project) points to several lessons learned <http://www.timesunion.com/opinion/article/Assessing-the-risks-of-fracking-4342593.php> .

"*Beware impact of fracking*" is a commentary urging caution from Dr Theo Colborn (The Endocrine Disruption Exchange), and Nadia Steinzor (Earthworks)

<http://www.timesunion.com/opinion/article/Beware-impact-of-fracking-4324911.php?cmpid=twitter> .

Those of us who have been following this issue closely know of many cases of illness near gas drilling operations and most are called anecdotes because pathways of exposure have not been identified, which is when you don't have a link from the toxin to the illness. Doctors who are practitioners haven't been educated on environmental issues and do not routinely take an environmental history, which is necessary if a causal effect is ever to be established. As an end result and most importantly, the complaints of the patients are not investigated by those tasked with protecting public health. And, if patients complain directly to the companies, and the families receive compensation, the records of the transactions are often sealed through non-disclosure agreements.

Even without proving a direct relationship, in other words, that a particular chemical (which is very difficult to obtain) caused a person's illness, that person's illness could be attributed to the gas development nearby by following these three guidelines, as described by Drs Brown and Walleigh:

- Temporal relationship** – was the development of the symptom (or exacerbation of pre-existing symptom) after the onset of gas extraction activities?

- Plausible exposure** – is there an identifiable exposure source in proximity to the individual experiencing symptoms?

- Absence of a more likely explanation** – Symptoms were not attributed to gas extraction activities if an individual had an underlying medical condition that was as (or more) likely to have caused the symptom.

There are many cases that fit the criteria of having been impacted by gas development nearby: a temporal relationship, plausible exposure, and absence of a more likely explanation. Studies implicate air contamination as the likely cause of the majority of illnesses. Breathing is mandatory, and, while a drinking water source might be replaced, air cannot.

Having spent time speaking with impacted people, I am convinced that the health of many of them living near gas wells, processing plants, compressors and other infrastructure is deteriorating and that it is a result of gas drilling activities. Given that exposures and illness increase over time and given that many instances of contamination and illness related to fracking never come to light due to non-disclosure agreements with the industry, I am concerned that this is the just beginning of a public health crisis. It would be prudent to address the entire process of gas extraction and distribution, and all potential sources of contamination, including air and dermal exposures, not just water impacts.

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Please see www.concernedhealthny.org and www.psehealthyenergy.org for additional updated peer-reviewed articles, reports and testimonies from health professionals.

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