

Tracing Fossil Fuel Companies' Contributions to Temperature Increase and Sea Level Rise

HIGHLIGHTS

Research led by the Union of Concerned Scientists links emissions from the products of fossil fuel producers, including ExxonMobil and Chevron, to changes in global climate. Emissions from the manufacture, extraction, and burning of the marketed products of 90 fossil fuel producers and cement manufacturers contributed nearly half of the rise in global average surface temperature and about 30 percent of the rise in global sea level between 1880 and 2010.

As taxpayers foot the bill for climate damages and adaptation costs, courts are beginning to consider holding fossil fuel producers accountable for damage they knew their products were causing. Scientific findings such as these can inform those efforts.

Climate change is happening now; it is all around us, causing increasing temperatures, rising seas, extreme drought, severe wildfires, and record flooding. Overwhelming scientific evidence shows that these impacts are the result of too much heat-trapping carbon being emitted into the atmosphere when we burn fossil fuels—coal, oil, and natural gas—to drive our cars, heat our homes, and power our lives. Communities are experiencing the impacts of climate change today. We know we need to reduce carbon emissions in order to avoid the most severe consequences of a warming world. But who's responsible? Who should pay the costs we incur as we suffer damages from and prepare for the burgeoning impacts of climate change?

Who Is Responsible for Climate Change?

Over the past decade, scientists have discovered ways to tease apart the natural and human factors that contribute to climate change impacts. Climate attribution science addresses how human activities are contributing to warming the atmosphere and ocean (IPCC 2013). The science of climate attribution is now able to quantify not only the degree to which human-caused climate change is contributing to sea level rise, but also the impact of heat-trapping emissions on changes in the frequency and severity of extreme heat, drought, and precipitation (NASEM 2016).

As cities and communities adjust to the changing climate, they are learning first-hand the human and economic cost of rising seas, extreme heat, and other climate impacts. For example, average global sea level has increased by eight inches since 1880, but is rising much faster on the US East Coast and Gulf of Mexico (Church and White 2011; Ishii et al. 2006). New York City has seen about one foot of sea level rise since 1880 (NOAA 2017). When Hurricane Sandy hit the East Coast



Storm surge from Hurricane Sandy rode in on seas about a foot higher than in the pre-industrial period due primarily to warming oceans and melting land ice. Here, the Brooklyn Battery Tunnel in New York is shown during the storm, on October 29, 2012 (left), and one year later (right).

Sea level rise added \$2 billion to the damages from Hurricane Sandy in New York City.

in 2012, storm surge caused widespread flooding throughout the region. That larger storm surge rode in on seas about 12 inches higher than in the pre-industrial period due primarily to warming oceans and melting land ice (NOAA 2017). Further analysis found that sea level rise added \$2 billion to the damages from Hurricane Sandy in New York City (Liefert 2015). In 2017, Hurricanes Harvey, Irma, and Maria illustrated the devastating impacts that extreme storms and extreme precipitation can have on ecosystems, property, and human lives.

Policy, legal, and academic debates about responsibility for climate change have long focused on countries' responsibility—the framework used for the international climate negotiations (UN 1992). However, attention is increasingly turning to non-state actors, particularly the producers of fossil fuels. Research published in 2014 found that nearly two-thirds of all industrial carbon emissions starting from the industrial revolution onward can be traced to just 90 carbon producers—investor- and state-owned fossil fuel companies such as ExxonMobil, BP, Chevron, Royal Dutch Shell, Peabody Energy, Gazprom, and Saudi Aramco, as well as cement manufacturers (Heede 2014). But the question remained: how much is the rise of global surface temperature and sea levels due to emissions tied to the products of a specific company?

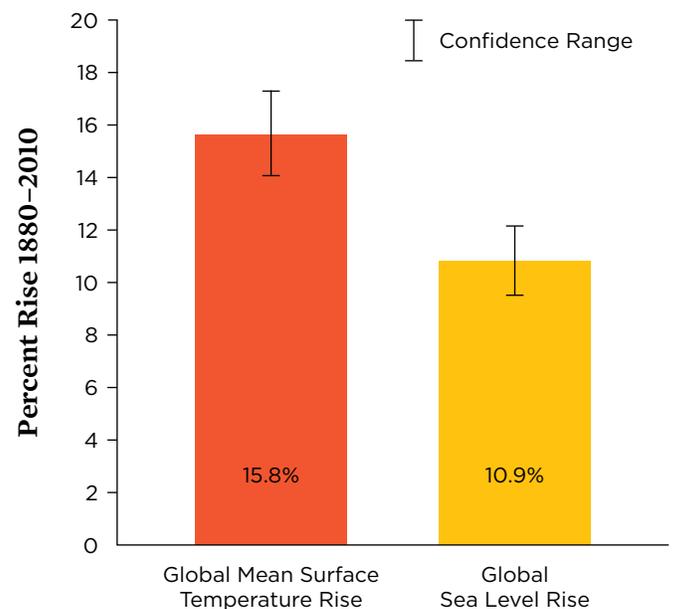
In 2017 a research team led by senior climate scientist at the Union of Concerned Scientists, Brenda Ekwurzel, published a study that answered that question. It incorporated emissions data from the 90 carbon producers in a simple, well-established climate model that captures how carbon dioxide and methane emitted into the Earth's atmosphere lead to the extra trapping of heat, driving increases in global surface temperature and sea level. Using this model, they were able to quantify the results of including or excluding different natural and human contributions to climate change—including the very specific contributions of emissions traced to these companies' products (Ekwurzel et al. 2017).

The new study analyzed the climate change impacts of each company's carbon dioxide and methane emissions for two time-periods: 1880–2010 and 1980–2010. By 1980, investor-owned fossil fuel companies were aware of the climate risks of their products and could have taken steps to reduce these risks and communicate them to shareholders and the public (Banerjee 2015; Frumhoff, Heede, and Oreskes 2015).

The results of this research show that emissions from the products of 90 major fossil fuel producers and cement manufacturers contributed nearly half of the global temperature rise and about 30 percent of global sea level rise between 1880 and 2010.

Emissions traced to 50 major investor-owned fossil fuel producers—which include ExxonMobil, Chevron, Royal Dutch Shell, BP, Peabody Energy, ConocoPhillips, and Total SA, among others—contributed roughly 16 percent of global average surface temperature increase and around 11 percent of sea level rise from 1880 to 2010 (Figure 1). Emissions traced to those same 50 companies from just 1980 to 2010, in a period when fossil fuel companies were well aware that their products were contributing to global warming, contributed approximately 10 percent of the global average temperature increase and about 4 percent of sea level rise since 1980—a volume of water equivalent to covering the area of the contiguous United States to a depth of around 1 foot.

FIGURE 1: Contribution of 50 Major Investor-Owned Carbon Producers to Global Average Temperature Increase and Sea Level Rise, 1880–2010



Researchers calculated the amount of global average temperature increase and global sea level rise resulting from emissions traced to 50 investor-owned carbon producers, including BP, Chevron, ConocoPhillips, ExxonMobil, Peabody Energy, Royal Dutch Shell, Total SA, and others. Confidence range reflects the difference in the findings from including or excluding tiny aerosol particles released when burning fossil fuels.

SOURCE: EKWURZEL ET AL. 2017.

Why Hold Fossil Fuel Companies Accountable for Climate Change?

There are several ways to think about responsibility for harmful impacts of industrial products. Individuals, corporations, and nation-states have all been held responsible for the impacts of products that harm people in various ways. For example, in cases involving tobacco and asbestos, responsibility for the products' harm went beyond individuals to manufacturers, holding them liable for damages (Oreskes and Conway 2010). To be sure, some responsibility for climate change is borne by governments, emitting industries (e.g., electric utilities), and individuals making lifestyle and consumer choices. But major fossil fuel companies, as producers of products that they knew had harmful impacts on people and the environment and yet chose to deceive the public about that harm, bear a distinct responsibility for harmful impacts that they could have taken steps to avoid.

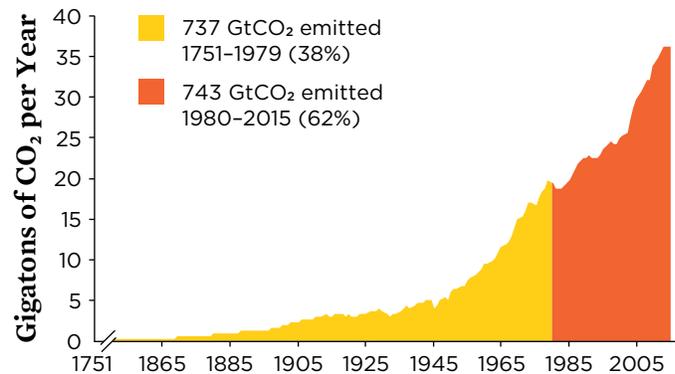
Evidence going back more than 40 years shows that a number of fossil fuel companies and their industry associations have long since understood the harm of their products, and yet carried out a decades-long campaign to sow doubt about the evidence of the climate risks of their products to avoid sensible limits on further emissions (Frumhoff, Heede, and Oreskes 2015).

Over the past several decades, as scientific evidence incontrovertibly showed that the burning of fossil fuels is a major contributor to global climate change, major fossil fuel companies such as ExxonMobil, Chevron, Royal Dutch Shell, BP, ConocoPhillips, Peabody Energy, and others could have responded in a variety of ways. They could have invested in carbon storage. They could have shifted toward low-carbon energy technologies. They could also have taken steps to warn policymakers and the public about potential adverse impacts from the use of their products (Shue 2017; Frumhoff, Heede, and Oreskes 2015).

But they did not. Rather, the evidence is clear that leading fossil fuel companies have consistently worked to discredit and disparage scientists and the scientific evidence linking fossil fuels and global warming, and to deny, diminish, or discount the reality and significance of climate change as a problem. Many of these companies have also strenuously lobbied—directly or through influential industry trade associations—to block policies encouraging the needed transition to low-carbon energy (Frumhoff, Heede, and Oreskes 2015).

Evidence indicates that major fossil fuel energy companies were well aware of the serious climate risks of burning their products in the 1970s (Banerjee 2015). By 1980, the harms became widely known to the public. A 1979 report by the National Academy of Sciences demonstrated the links between carbon dioxide and climate change. In order to reduce the

FIGURE 2: Annual Global CO₂ Emissions from Fossil Fuel and Cement, 1751–2015



Though the Industrial Revolution began more than 250 years ago, more than 60% of industrial carbon emissions have been released only since 1980.

SOURCE: BODEN, MARLAND, AND ANDRES 2013.

generation of heat-trapping gases, Congress introduced the National Energy Policy Act of 1988, and the Intergovernmental Panel on Climate Change was created (NRC 1979). However, fossil fuel companies responded to growing public awareness by resisting the scientific consensus—investing in measures to sow doubt and confusion about the science of climate change and the need for regulation (Mulvey and Shulman 2015).

These fossil fuel companies, given what they knew and when, have a particular responsibility to assist in dealing with the harmful and avoidable impacts of their products. This responsibility includes renouncing climate disinformation, reducing their own emissions in the context of a company-wide plan consistent with keeping global temperature increase well below 2°C above pre-industrial levels, supporting policies to reduce emissions, fully disclosing climate risks associated with their products, financing adaptation efforts, and participating in compensation for climate loss and damages.

Leading fossil fuel companies have consistently worked to deny or diminish the reality of climate change as a problem.

The Increasing Costs of Climate Change: Who Should Pay?

Our ability to quantify the damage due specifically to human-caused climate change is growing quickly. Scientists and economists have now determined that:

- Sea level rise contributed an additional \$2 billion in damage to the havoc wrought by Hurricane Sandy in New York City (Liefert 2015).
- Human-caused warming worsened the California drought of 2012 to 2015 by between 15 and 20 percent (Williams et al. 2015). The drought resulted in a \$3 billion cost to the agricultural sector in 2015 alone (Howitt et al. 2015).
- Nearly 600 deaths from extreme heat in Paris and London in 2003 resulted from human-caused warming (Mitchell et al. 2016).

The costs of preparing, responding, and adapting to these impacts is also large and growing.

- By 2030, the average annual costs of coastal storms in the US East and Gulf Coasts alone are projected to increase by between \$2 billion and \$3.5 billion due to the rising sea level and associated storm surges (Gordon 2014).
- Developing countries will need climate adaptation funding estimated between \$140 and \$300 billion per year by 2030 and between \$280 and \$500 billion per year by 2050 (UNEP 2016).
- New York City now projects that it will cost \$19.5 billion to prepare for climate change impacts through 2030 (New York City 2013).
- The annual damage of climate change to capital assets in the Gulf Coast alone could be \$2.7 to \$4.6 billion by 2030, and \$8.3 to \$13.2 billion by 2050 (Melillo, Richmond, and Yohe 2014).

To be sure, responsibility for climate change is spread across society—governments, carbon-emitting industries, and individuals all bear some responsibility. But given that the world's largest fossil fuel companies have actively worked to deceive the public and block climate action while knowing

The world's largest fossil fuel companies must be held responsible for their actions.

the harm of their products, they must be held responsible for their actions (Frumhoff, Heede, and Oreskes 2015).

As taxpayers—particularly those from climate-vulnerable communities—foot the bill for climate damages and adaptation costs, it's time to hold fossil fuel producers accountable for damage they knew their products were causing. Shareholders in publicly traded fossil fuel companies increasingly demand that companies assess and report on climate-related financial risks as well as lay out a path forward to plan for a world free from carbon pollution (Mufson 2017; TCFD 2017).

City, state, and federal officials are facing the reality of the climate change price tag and looking for ways to cover the costs. Lawsuits have been filed that seek to hold fossil fuel companies liable for damages from major storms, extreme heat, loss of land due to sea level rise, or efforts by cities and communities to prepare for and limit climate impacts. If and when companies are held liable for damages, scientific findings such as the study by Ekwurzel and coauthors can assist juries and judges in monetizing these damages.

REFERENCES

- Banjerjee, N. 2015. Exxon's oil industry peers knew about climate dangers in the 1970s, too. Inside Climate News. Online at <https://insideclimatenews.org/news/22122015/exxon-mobil-oil-industry-peers-knew-about-climate-change-dangers-1970s-american-petroleum-institute-api-shell-chevron-texaco>, accessed August 22, 2017.
- Boden, T.A., G. Marland, and R.J. Andres. 2016. Global, regional, and national fossil-fuel CO₂ emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy. doi 10.3334/CDIAC/00001_V2016
- Church, J.A., and N.J. White. 2011. Sea-level rise from the late 19th to the early 21st century. *Survey in Geophysics* 32(4-5):585–602.
- Ekwurzel, B., J. Boneham, M.W. Dalton, R. Heede, R.J. Mera, M.R. Allen, and P.C. Frumhoff. 2017. The rise in global atmospheric CO₂, surface temperature, and sea level from emissions traced to major carbon producers. *Climatic Change* 144(4):579–590.
- Frumhoff, P., R. Heede, and N. Oreskes. 2015. The climate responsibilities of industrial carbon producers. *Climatic Change* 132:157.
- Gordon, K. 2014. *A climate risk assessment for the United States*. Risky Business. Online at https://riskybusiness.org/site/assets/uploads/2015/09/RiskyBusiness_Report_WEB_09_08_14.pdf, accessed July 10, 2017.
- Heede, R. 2014. Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Climatic Change* 122(1-2):229–341.
- Howitt, R., D. MacEwan, J. Medellín-Azuara, J. Lund, and D. Sumner. 2015. Economic analysis of the 2015 drought for California agriculture. Davis, CA: UC Davis Center for Watershed Sciences, ERA Economics, and UC Agricultural Issues Center. Online at https://watershed.ucdavis.edu/files/biblio/Final_Drought%20Report_08182015_Full_Report_WithAppendices.pdf, accessed July 10, 2017.

- Intergovernmental Panel on Climate Change (IPCC). 2013: Summary for policymakers. In *Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change*, edited by T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Idgley. Cambridge, UK, and New York, NY: Cambridge University Press.
- Ishii, M., M. Kimoto, K. Sakamoto, and S. Iwasaki. 2006. Steric sea level changes estimated from historical ocean subsurface temperature and salinity analyses *Journal of Oceanography* 62:155–170.
- Leifert, H. 2015. Sea level rise added \$2 billion to Sandy's toll in New York City. *Eos* 96.
- Melillo, J.M., T.C. Richmond, and G.W. Yohe, eds. 2014. *Climate change impacts in the United States: The third national climate assessment*. Washington, DC: US Global Change Research Program. doi:10.7930/JOZ31WJ2.
- Mitchell, D, C. Heavyside, S. Vardoulakis, C. Huntingford, G. Masato, B. Guillo, P. Frumhoff, A. Bowery, 2016. Attributing human mortality during extreme heat waves to anthropogenic climate change. *Environmental Research Letters* 11(7). doi:074006.
- Mufson, S. 2017. Financial firms lead shareholder rebellion against ExxonMobil climate change policies. *Washington Post*. Online at <https://www.washingtonpost.com/news/energy-environment/wp/2017/05/31/exxonmobil-is-trying-to-fend-off-a-shareholder-rebellion-over-climate-change>, accessed October 4, 2017.
- Mulvey, K., and S. Shulman. 2015. *The climate deception dossiers: Internal fossil fuel industry memos reveal decades of corporate misinformation*. Cambridge, MA: Union of Concerned Scientists. Online at www.ucsusa.org/global-warming/fight-misinformation/climate-deception-dossiers-fossil-fuel-industry-memos, accessed August 17, 2017.
- National Academies of Science. 1979. *Carbon dioxide and climate: a scientific assessment*. National Academies Press, Washington, D.C.
- National Academies of Sciences, Engineering, and Medicine (NASEM). 2016. *Attribution of extreme weather events in the context of climate change*. Washington, DC: The National Academies Press. Online at <https://doi.org/10.17226/21852>, accessed August 13, 2017.
- National Oceanic and Atmospheric Administration (NOAA). 2017. Tides and current. Online at https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8518750, accessed August 13, 2017.
- National Research Council (NRC). 1979. *Carbon dioxide and climate: a scientific assessment*. National Academies Press, Washington, D.C. Online at <https://www.nap.edu/catalog/12181/carbon-dioxide-and-climate-a-scientific-assessment>.
- New York City. 2013. *A stronger, more resilient New York. Plan NYC*. Online at www.nyc.gov/html/sirr/html/report/report.shtml, accessed July 10, 2017.
- Oreskes, N., and E.M. Conway. 2010. *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. New York, NY: Bloomsbury Publishing, Inc.
- Shue, H. 2017. Responsible for what? Carbon producer CO₂ contributions and the energy transition. *Climatic Change* 144(4):591–596.
- Task Force on Climate-Related Financial Disclosures (TCFD). 2017. Final report: Recommendations of the Task Force on Climate-Related Financial Disclosures. Online at www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf, accessed July 10, 2017.
- Wilford, J.N. 1988. His bold statement transforms the debate on greenhouse effect. *New York Times*, August 23. Online at www.nytimes.com/1988/08/23/science/his-bold-statement-transforms-the-debate-on-greenhouse-effect.html, accessed July 10, 2017.
- Williams, P.A., R. Seager, J.T. Abatzoglou, B.I. Cook, J.E. Smerdon, and E.R. Cook. 2015. Contribution of anthropogenic warming to California drought during 2012–2014. *Geophysical Research Letters* 42(16):6819–6828.
- United Nations (UN). 1992. United Nations Framework Convention on Climate Change. FCCC/INFORMAL/84 GE.05-62220 (E) 200705. Online at <https://unfccc.int/resource/docs/convkp/conveng.pdf>, accessed September 28, 2017.
- United Nations Environment Programme (UNEP). 2016. Cost of adapting to climate change could hit \$500 per year by 2050. Online at www.unep.org/northamerica/news/2016/cost-adapting-climate-change-could-hit-500-billion-year-2050, accessed August 13, 2017.

Union of Concerned Scientists

FIND THIS DOCUMENT ONLINE: www.ucsusa.org/climateresponsibility

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

NATIONAL HEADQUARTERS

Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE

1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE

500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 451-3785

MIDWEST OFFICE

One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751