

Tracing Fossil Fuel Companies' Contribution to Climate Change and Ocean Acidification

HIGHLIGHTS

Research led by the Union of Concerned Scientists (UCS) quantifies contributions of emissions from the products of fossil fuel companies, including ExxonMobil and Chevron, to changes in global climate.

Emissions from 88 of the largest fossil fuel producers and cement manufacturers' products contributed more than half of the increase in ocean acidification, around half of the rise in global average surface temperature, and about a third of the rise in global sea level between 1880 and 2015.

As taxpayers continue to 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 deliberations.

Burning fossil fuels for more than a century has released heat-trapping carbon dioxide (CO₂) and other gases into the atmosphere, altering the world's climate and acidifying its oceans. Overwhelming scientific evidence shows that burning coal, oil, and natural gas—to drive our cars, heat our homes, and power our lives—has caused increasing temperatures, sea level rise, extreme drought, severe wildfires, and record flooding. The ocean has absorbed about 29 percent of global CO₂ emissions since the end of the preindustrial era, resulting in surface waters becoming 30 percent more acidic (Jewett and Romanou 2017). Communities are already suffering. We know we need to reduce carbon emissions in order to avoid the most severe climate scenarios. But who is responsible? Who should pay for climate damages and adaptation costs to better prepare communities coping with burgeoning impacts?

Who Is Responsible for Climate Change and Ocean Acidification?

Over the past decade, scientists have discovered ways to tease apart the natural and human factors that contribute to changes in the climate and the oceans. Climate attribution science addresses how human activities contribute to warming the atmosphere and oceans (IPCC 2013). Scientists are now able to quantify



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Oceans are becoming more acidic as they absorb CO₂ from the atmosphere, harming corals and other species that build their skeletons or shells from calcium carbonate. If global average temperatures rise to 2°C or more above preindustrial levels, nearly all of the world's warm-water coral reefs could disappear.

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not only the degree to which human-caused emissions contribute to sea level rise and ocean acidification, but also the degree to which heat-trapping emissions affect the frequency and severity of extreme heat, drought, and precipitation events (Blunden and Arndt 2019; NASEM 2016).

Communities are learning firsthand the human and economic cost of climate change. Average global sea level has increased by seven to eight inches since 1900, but sea level is rising much faster along the US east coast and in the Gulf of Mexico (Sweet et al. 2017). New York City has seen about one foot of sea level rise since 1880 (NOAA 2017). When Hurricane Sandy hit in 2012, storm surge caused widespread flooding in the East Coast. That storm surge rode in on seas about a foot higher than they were in the preindustrial period, due primarily to warming oceans and shrinking land ice (NOAA 2017). An analysis found that sea level rise added \$2 billion to the damages experienced in New York City (Leifert 2015).

Coastal and marine ecosystems are under tremendous stress. Persistent stressors include nutrient pollution and overfishing. But ocean acidification and climate impacts such

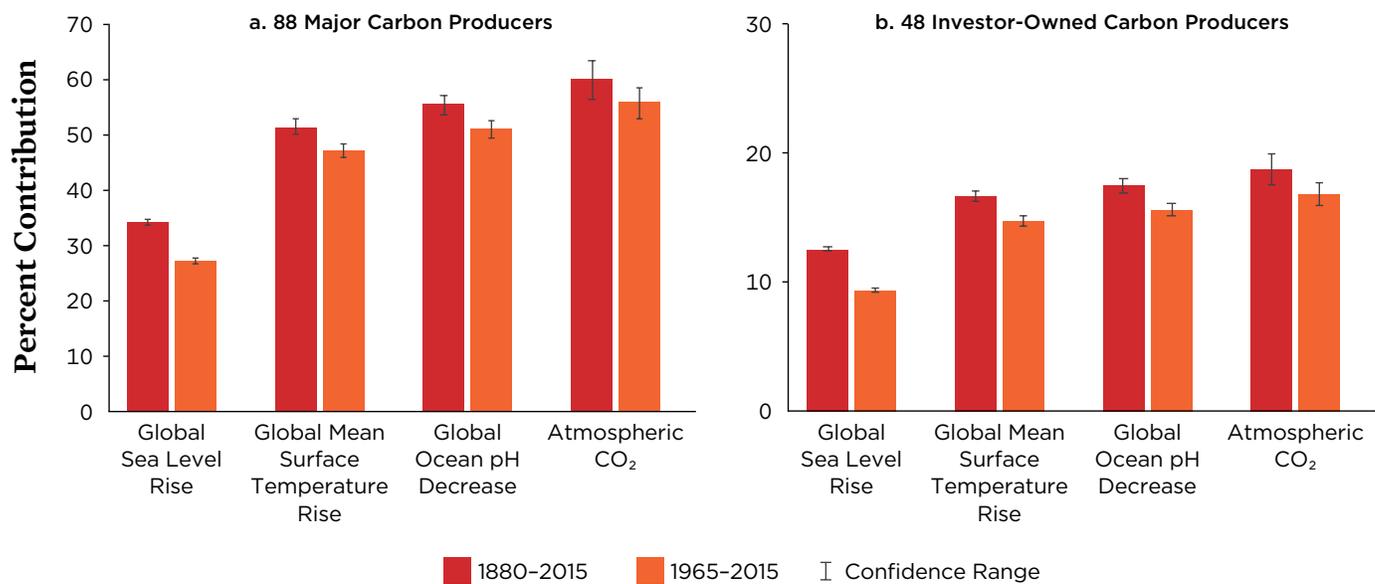
as warming waters, melting ice, and coastal erosion combine with them to pose real threats to the survival of many marine species. Ocean acidification is particularly detrimental to species that build their skeletons or shells from calcium carbonate, including clams, mussels, crabs, phytoplankton, and corals (Kroeker et al. 2013; Feely, Doney, and Cooley 2009). If CO₂ emissions continue unabated, it is estimated that by the end of the century, annual supplies of clams could decrease by 35 percent, of oysters by 50 percent, and of scallops by 55 percent (EPA 2017). Ocean acidification also hinders the ability of corals to grow back after bleaching events caused by high water temperatures because it reduces the amount of calcium carbonate available. If global average temperatures rise to 2°C or more above preindustrial levels, nearly all of the world’s warm-water coral reefs could disappear (IPCC 2018).

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 has increasingly turned to nonstate actors, particularly fossil fuel producers.



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).

FIGURE 1. Contribution of Major Carbon Producers to Ocean Acidification and Climate Impacts, 1880–2015 and 1965–2015



Researchers calculated the amount of atmospheric CO₂, ocean acidification, global average temperature increase, and global sea level rise between 1880 and 2015 resulting from emissions traced to 88 industrial carbon producers as well as a subset of the 48 investor-owned carbon producers including BP, Chevron, ExxonMobil, Royal Dutch Shell, and others. Most of the contribution to atmospheric CO₂ and subsequent impacts have occurred since 1965, by which time fossil fuel companies were well aware of the risks of their products.

Note: All numbers represent the best estimate full forcing case.

SOURCE: LICKER ET AL. 2019.

Research published in 2014 found that nearly two-thirds of all industrial carbon emitted since the beginning of the industrial revolution 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, sea levels, and ocean acidification due to each specific company’s products’ emissions?

Research teams led by UCS senior climate scientists with collaborators have published two studies that answer this question. They incorporated emissions data from the largest carbon producers in a simple, well-established climate model that captures how CO₂ and methane emitted into Earth’s atmosphere and absorbed by the oceans lead to ocean acidification and how the extra trapping of heat drives increases in global surface temperature and sea level rise. Using this model, they were able to quantify the results of including or excluding different natural and human contributions to climate change—including the specific contributions of

emissions traced to these companies’ products (Licker et al. 2019; Ekwurzel et al. 2017).

The research looks at the climate change effects of each company’s CO₂ and methane emissions for two time periods: 1880 to 2015 and 1965 to 2015. The latter timeframe is important because investor-owned fossil fuel companies were aware of the climate risks caused by their products in the mid 1960s and could have taken steps to reduce these risks and communicate them to shareholders and the public (Franta 2018; Banerjee 2015; Frumhoff, Heede, and Oreskes 2015). Here are the findings:

- Emissions from 88 of the largest fossil fuel producers’ and cement manufacturers’ products contributed more than 55 percent of the increase in ocean acidification, about 52 percent of the global temperature rise, and about 34 percent of global sea level rise between 1880 and 2015 (Figure 1a).
- Emissions traced to 48 major investor-owned fossil fuel producers—which include ExxonMobil, Chevron, Royal Dutch Shell, BP, Peabody Energy, and

Fossil fuel companies were aware 50 years ago of the risks of their products, and chose to deceive the public instead of take action.

ConocoPhillips—contributed about 17 percent of the rise in ocean acidification, about 17 percent of global average surface temperature increase, and around 13 percent of sea level rise from 1880 to 2015 (Figure 1b).

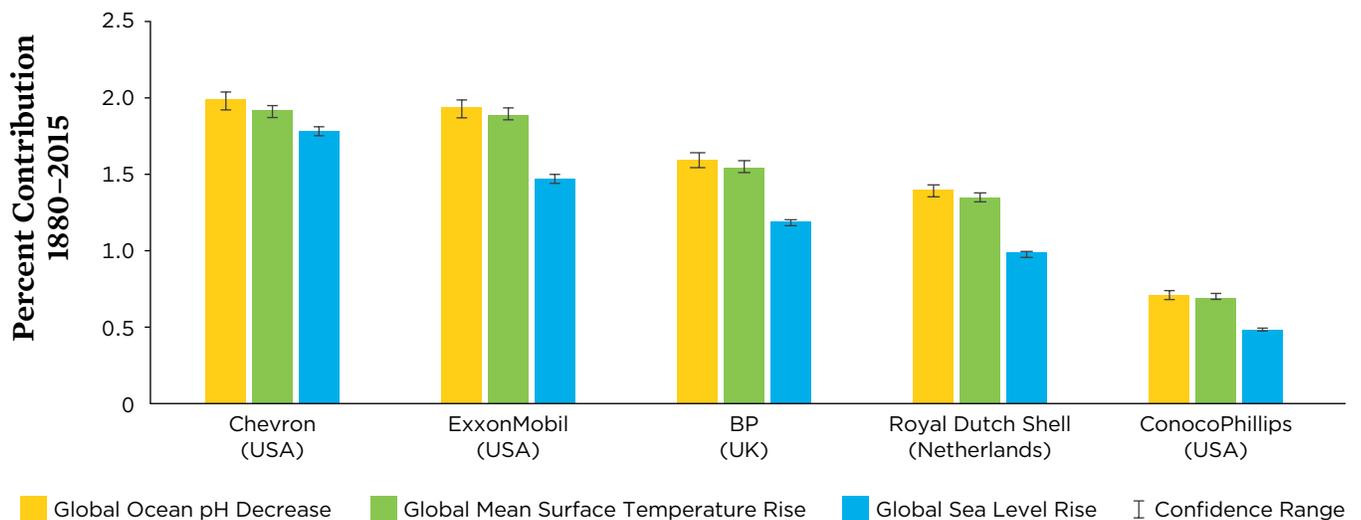
- Emissions traced to those same 48 companies from just 1965 to 2015, a period during which fossil fuel companies were well aware that their products were leading to global warming, contributed approximately 15 percent of the increase in ocean acidification, around 15 percent of the global average temperature increase, and about 9 percent of sea level rise over the period 1880–2015.

- Emissions traced from 1965 to 2015 to just the top five investor-owned oil and gas companies—Chevron, Exxon-Mobil, Royal Dutch Shell, BP, and ConocoPhillips—have contributed approximately 8 percent of the increase in ocean acidification, more than 7 percent of the global average temperature increase, and about 6 percent of sea level rise over the period 1880–2015 (Figure 2).

Why Hold Fossil Fuel Companies Accountable?

Individuals, corporations, and nation-states have all been held responsible for decisions and actions that cause harm to people, communities, the economy, and ecosystems. In cases involving tobacco, asbestos, and opioid pharmaceuticals, courts have held manufacturers responsible for some portion of product-related damages (Hoffman 2019; Oreskes and Conway 2010). To be sure, governments, emitting industries (e.g., electric utilities), and individuals making lifestyle and consumer choices bear some responsibility for climate change. But major fossil fuel companies—which chose to deceive the public about the harm they knew their products cause to

FIGURE 2. Contribution of Top Five Investor-Owned Carbon Producers to Ocean Acidification and Climate Impacts, 1965–2015



Emissions traced to each of the top five investor-owned carbon producers—Chevron, ExxonMobil, BP, Royal Dutch Shell, and ConocoPhillips—from 1965 to 2015 contributed measurable amounts to the increases in ocean acidification, global average temperature increase, and global sea level over the period 1880–2015. Most of the historical carbon emissions have occurred since 1965, by which time these and other companies were well aware that their products were leading to global warming.

Note: Top five investor-owned companies were determined by historical emissions contribution to change over the period 1880–2015. All numbers represent the best estimate full forcing case.

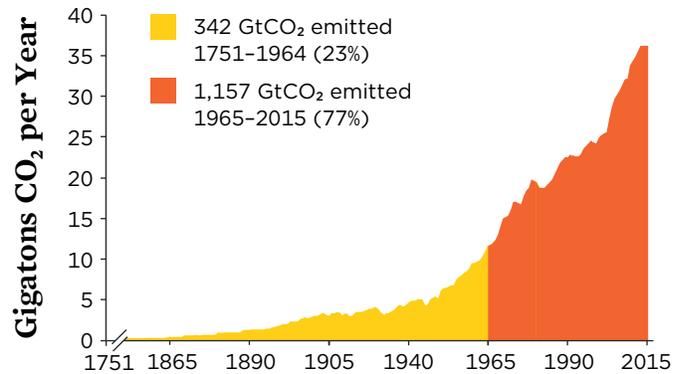
SOURCES: LICKER ET AL. 2019; HEEDE 2014.

people and the environment—bear a distinct responsibility for harm they could have taken steps to avoid.

Evidence going back more than 50 years shows that a number of fossil fuel companies and their industry associations have long understood that their products caused harm (Figure 3). Yet they campaigned for decades to sow doubt about the evidence of their products’ climate risks to prevent sensible limits on further emissions (Franta 2018; Frumhoff, Heede, and Oreskes 2015). In 1965, the American Petroleum Institute, the major oil industry trade association, shared with industry leaders the findings from leading scientists on CO₂ pollution from burning fossil fuels, noting that “there is still time to save the world’s peoples from catastrophic consequences of pollution, but time is running out” and that the addition of CO₂ to the atmosphere from burning coal, oil, and natural gas could, by the year 2000, “cause marked changes in climate beyond local or even national efforts” (Franta 2018). By 1988, the harms became widely known to the public (Banerjee 2015; Frumhoff et al. 2015). In order to reduce the 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 and their trade associations responded to growing public awareness by resisting the scientific consensus—investing millions of dollars in measures to sow doubt and confusion about the science of climate change and the need for regulation (Mulvey and Shulman 2015).

Major fossil fuel companies could have responded to the scientific evidence 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 harms caused by use of their products (Shue 2017; Frumhoff, Heede, and Oreskes 2015).

FIGURE 3. Annual Global CO₂ Emission from Fossil Fuel and Cement, 1751–2015



Though the Industrial Revolution began more than 250 years ago, more than 75 percent of industrial carbon emissions have been released only since 1965, when fossil fuel companies were well aware of the risks of their products.

SOURCE: BODEN, MARLAND, AND ANDRES 2016.

But they did not. Rather than change their business models, 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).

Given what they knew and when, major fossil fuel companies have a particular responsibility to assist in dealing with their products’ harmful and avoidable impacts. This responsibility includes renouncing climate disinformation, reducing their own emissions in the context of companywide

Evidence going back more than 50 years shows that a number of fossil fuel companies and their industry associations have long understood that their products caused harm.



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Fossil fuel companies have known about the risks of their products for decades—but instead of taking action to address the problem, they worked to discredit the scientific evidence linking fossil fuels and global warming, and strenuously lobbied to block policies encouraging the needed transition to low-carbon energy.

Leading fossil fuel companies have consistently worked to discredit and disparage scientists and the scientific evidence linking fossil fuels and global warming.

plans consistent with keeping global temperature increase well below 2°C above preindustrial 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.

The Increasing Costs: Who Should Pay?

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

- sea level rise contributed an additional \$2 billion in damage to the havoc Hurricane Sandy wrought in New York City (Leifert 2015);

- in the mid-2000s, larval shellfish mortality due to ocean acidification depressed oyster hatcheries in the Pacific Northwest, putting more than 3,000 jobs at risk (Barton et al. 2015; Barton et al. 2012);
- nearly 600 deaths related to extreme heat in Paris and London in 2003 resulted from human-caused warming (Mitchell et al. 2016); and
- Hurricane Harvey cost about \$125 billion—second in the period of record only to Hurricane Katrina, which cost about \$161 billion (Blake and Zelinsky 2017).

The cost of preparing for and responding and adapting to these impacts is also large and growing.

- By 2030, the average annual cost of storms hitting the US east and Gulf coasts alone is projected to increase



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Extreme heat is already posing a risk to public health and the United States is facing a potentially staggering expansion of dangerous heat over the coming decade. Taking bold action today to reduce carbon emissions can prevent the worst from becoming reality.

It is time to hold fossil fuel producers accountable for damage they knew their products were causing.

by \$2 billion to \$3.5 billion due to the rising sea level and associated storm surges (Gordon 2014).

- New York City now projects that it will cost \$19.5 billion to prepare for climate change impacts through 2030 (New York City 2013).
- In the Gulf Coast alone, the annual damage to capital assets caused by climate change could be \$2.7 billion to \$4.6 billion by 2030 and \$8.3 billion to \$13.2 billion by 2050 (Melillo, Richmond, and Yohe 2014).

As taxpayers—particularly those in climate-vulnerable communities—and other sectors of the economy foot the bill for climate damages and adaptation costs, it is 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 they disclose climate-related financial risks, commit to emissions reductions consistent with achieving the Paris climate agreement’s global temperature targets, and align their lobbying with stated company positions on climate change (Climate Action 100+ 2019; Mufson 2017; TCFD 2017). A 2019 public opinion survey conducted by the Yale Program on Climate Change Communication and supported by UCS found that a majority of people across the United States (57 percent) believe fossil fuel companies are responsible for, and should pay for some portion of, climate damages (Marlon et al. 2019).

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

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