FACT SHEET

Tracing the Tides

How Major Carbon Producers Drive Sea Level Rise and Climate Injustice

HIGHLIGHTS

Major fossil fuel producers have played a large role in driving climate change and increasing global temperatures and sea levels, prompting questions about who bears responsibility. New research by the Union of Concerned Scientists finds that nearly half of the increase in present-day average surface temperature and one-third of present-day sea level rise can be traced to emissions from the 122 largest fossil fuel producers and cement manufacturers. This research also shows that due to the delay between heat-trapping emissions and the consequential impacts on ocean temperatures and ice sheets, previous emissions have all but guaranteed as much as 22 inches of additional sea level rise by 2300, regardless of future reductions in climate-warming pollution. These findings underscore the urgency of phasing out fossil fuels, highlight the intergenerational injustice of continuing their use, and can inform discussions about major corporations' responsibility for current and future climate impacts.

Introduction

Rising seas are affecting coastal communities around the world through the contamination of fresh water, erosion, flooding, increased storm surge, and the resulting damage to lives and property. Globally, sea levels have risen, on average, nearly a foot over the past 120 years (Fox-Kemper et al. 2021). In recent years, large hurricanes and storms—such as Hurricanes Helene, Ian, and Sandy—have caused billions of dollars in damages, claimed lives, and wreaked havoc on ecosystems (Muller et al. 2025; Strauss et al. 2021). Projections show that sea level rise and its impacts will continue to worsen in the future, with much of the United States's critical infrastructure, including schools and public housing, at risk of flooding by mid-century (Dahl et al. 2024).

The damaging consequences of rising seas, however, are not evenly distributed. Individuals and countries that have contributed the least to climate change, such as island nations, are bearing the brunt of its impacts (Sadai et al. 2022), raising urgent questions like, "Who should bear the costs of damages, adaptation, and recovery?" Such questions are at the center of international negotiations, legal debates, and scientific research. High-emitting countries like the United States, China, and Russia have played a significant role in driving climate change and must take responsibility for both their historical emissions and the disproportionate harm faced by climate- vulnerable communities within and beyond their borders.

Still, national emissions are not the whole story—corporate actors have also played a central role in driving climate change. Major fossil fuel companies have not only contributed significantly to global emissions, but did so with knowledge of the risks and harms of their products (Franta 2022; Supran and Oreskes 2017). Instead of acting responsibly, they misled

the public, spread disinformation, and obstructed climate policies that could have curbed emissions decades ago (Franta 2018; Supran and Oreskes 2017; Supran, Rahmstorf, and Oreskes 2023). Holding both countries and corporations accountable is essential for ensuring a just and effective response to climate change (Frumhoff, Heede, and Oreskes 2015; Wentz et al. 2023).

New research by the Union of Concerned Scientists (UCS) adds to the evidence base that begins to answer questions of responsibility. A new study finds that heat-trapping emissions traced to the world's 122 largest fossil fuel and cement producers—hereafter, Carbon Majors—during the period 1854–2020 have contributed to nearly half of the rise in present-day surface air temperature and nearly one-third of the observed global mean sea level rise to date (Sadai et al. 2025).

Looking to the year 2300, this research shows that emissions attributed to the Carbon Majors over 1854–2020 have all but guaranteed an additional 10 to 22 inches of sea level rise, on average, around the world. And this is just the projection from past heat-trapping emissions from the Carbon Majors and does not include additional sea level rise due to future heat-trapping emissions or emissions from other sources. The prospect of nearly two additional feet of sea level rise—on top of the foot already observed—represents a profound escalation in risk from damage to infrastructure, flooding, and further coastal erosion, particularly for low-lying coastal communities and island nations already struggling with the impacts of rising seas.

As countries and communities seek to address climate change through compensation for loss and damage, legislation, and litigation, this analysis highlights the contribution of major carbon producers and underscores the responsibility they bear for the impacts of climate change.

Sea Level Rise: How It Works

Sea levels respond to rising global temperatures slowly, over hundreds and thousands of years. As a result, the sea level rise attributable to emissions from the last century will not be realized for hundreds of years into the future.

Two factors control this long-term response. The first, called thermal expansion, results from the enormous amount of heat absorbed by the oceans, which slowly causes the water to expand. The ocean has absorbed more than 90 percent of all the excess heat retained in Earth's climate system by the effects of heat-trapping emissions (Fox-Kemper et al. 2021).

The second factor is the continued melting of glaciers and of the Greenland and Antarctic ice sheets due to increased melt driven by atmosphere and ocean warming, and the destabilization of ice shelves, all of which contribute to the transfer of ice mass into the ocean. Observational evidence shows that sea levels already rose nearly a foot between 1901 and 2018 (Fox-Kemper et al. 2021), with rates increasing over time as climate change—driven by the burning of fossil fuels—worsens.

Growing Impacts of Sea Level Rise

The impacts of sea level rise are already widespread (Dahl et al. 2024) and are projected to worsen as humans continue to release record amounts of heat-trapping emissions (Friedlingstein et al. 2024). While more frequent flooding and greater storm surge are the primary impacts from sea level rise, the erosion of coastlines, salinization of freshwater

supplies and ecosystems, and widespread economic losses also pose serious risks to the longevity and resilience of coastal communities.

The damage and harm caused by sea level rise are unevenly distributed across the world, with those who have contributed the least to climate change often experiencing the worst of its impacts. Island nations, such as the members of the Alliance of Small Island States, represent a particularly prominent example of this injustice (Sadai et al. 2022). Rising seas threaten their physical landscapes through coastal erosion, loss of habitable land, and saltwater intrusion, while endangering cultural heritage sites, traditional practices, and ways of life deeply tied to the land and ocean.

Economically, these nations face mounting costs from damage to infrastructure, disruptions to traditional industries, and loss of tourism revenue. In the most extreme cases, rising seas pose an existential threat to cultural connections to land, with the risk of forced displacement and potential challenges to the legal and political recognition of their territories. In response, these nations have sought justice through international negotiations and international courts.

Box 1. A Brief History of Fossil Fuel Companies and Climate Change

For decades, fossil fuel companies have understood the threat their products pose to the climate. As early as the 1950s, industry scientists warned that burning fossil fuels would increase global temperatures and lead to rising seas (Franta 2018). Internal documents from major fossil fuel companies, including ExxonMobil and Shell, show that by the 1970s and 1980s, they had developed sophisticated climate models that projected the very impacts we see today (Supran et al. 2023).

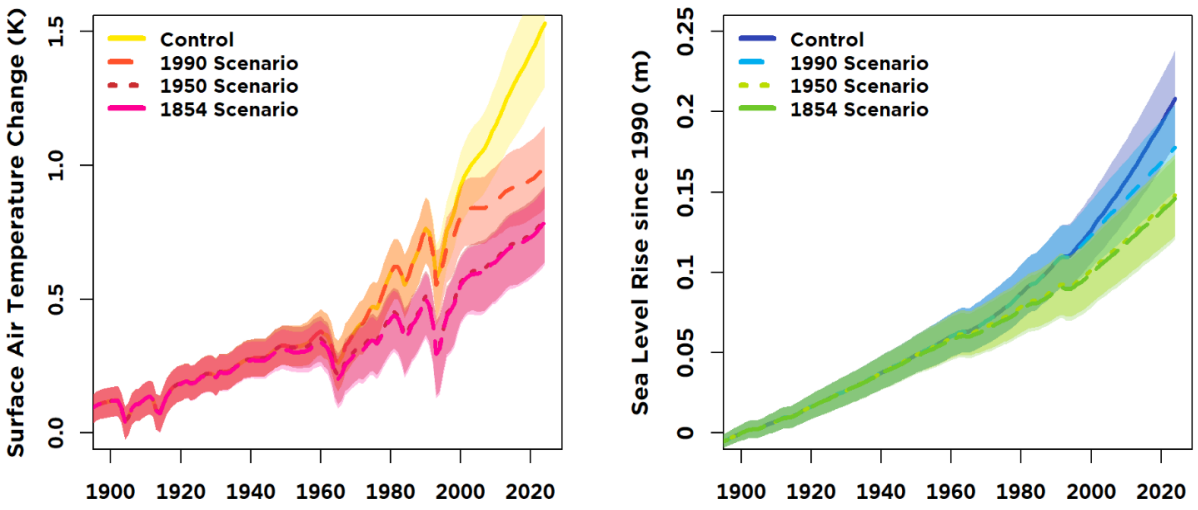
Rather than act on this knowledge, these companies spent decades blocking climate policies that could have reduced emissions, funding disinformation campaigns, and misleading the public (Franta 2022; Supran and Oreskes 2017). This deliberate deception delayed climate action and "locked in" irreversible impacts, including future sea level rise (Ekwurzel et al. 2017; Licker et al. 2019). The consequences of this inaction are now undeniable.

Findings

UCS used a combination of data and modeling to quantify the amount of global average surface temperature increase and sea level rise attributable to emissions traced to the 122 largest fossil fuel producers and cement manufacturers. By removing emissions traceable to these major carbon producers at three key points in history, this research modeled the outcome of earlier emissions reductions on present-day air temperature and sea level rise, giving a view of impacts that could have been avoided if a different path had been taken. Indeed, this research shows that most severe impacts could have been avoided with earlier actions to reduce emissions (Figure 1).

Nearly four decades ago, governments worldwide acknowledged the reality of human-caused climate change and formed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 to address the issue. Had the Carbon Majors reduced production at that time, global temperatures today would be 0.18°C–0.23°C lower (equivalent to 21 percent less warming, confidence interval [CI] 17–26 percent), and sea levels would be 0.02–0.03 meters (0.7–1.2 inches) lower (equivalent to 14 percent less sea level rise, CI 11–17 percent) (Figure 1).

Figure 1. Modeled Current Temperature and Sea Level Rise, Representing Four Emissions Scenarios



Emissions traced to the 122 largest fossil fuel companies and cement manufacturers have contributed substantially to present-day air temperature increase at Earth's surface (left) and sea level rise (right). Yellow, orange, and red lines show median global average temperature increase in four scenarios, with corresponding shading indicating the 10th and 90th percentile confidence intervals. Blue and green lines show median global sea level rise since 1900, with shading representing the tenth and 90th percentile confidence intervals.

SOURCE: Sadai et al. 2025.

Our results show that emissions traced to the Carbon Majors from 1854 to 2020 contributed to 45 percent (CI 37–58 percent) of present-day temperature increase and 29 percent (CI 24–37 percent) of present-day sea level rise. This research highlights the consequences of the industry's early deception about its internal knowledge of climate change and its continued delay and disruption of meaningful policies that address the root cause of climate change: the human burning of fossil fuels.

Further, this research quantifies the projected magnitude of locked-in sea level rise—that is, how much future sea levels could rise just based on past emissions. We show that by the year 2300, emissions from Carbon Majors' past production could lead to an additional 14 inches (CI 10–22 inches), on average, globally, regardless of future emissions trajectories. Future sea

levels will be higher than they are now, with the overall magnitude being determined by future heat-trapping emissions, leading to more frequent and severe coastal flooding; heightened risks to infrastructure, freshwater supplies, and ecosystems; and permanent land loss in low-lying communities. These results underscore the urgency of reducing reliance on fossil fuels and emphasize the critical role that adaptation to the consequences of climate change will play in addressing the impacts of sea level rise.

Holding Major Carbon Producers Accountable

As the physical, economic, and social impacts of climate change grow increasingly severe, holding the largest fossil fuel companies accountable is essential to ensure that those most responsible for climate change bear the costs of its damages—rather than the burden falling on the communities least responsible and most impacted. Corporate accountability involves more than financial compensation; it involves ensuring justice for those harmed, exposing decades of deception, and preventing the continued obstruction of climate solutions. As a result, legal and policy tools are being deployed around the world to hold these companies accountable.

Legal Pathways to Accountability

Lawsuits against fossil fuel companies are a growing and powerful mechanism for corporate accountability. In the United States, cities, counties, and states are suing major oil and gas corporations for their role in deceiving the public and driving climate impacts. Some cases allege consumer fraud over misleading marketing about fossil fuels, while others seek damages for climate disasters fueled by these companies' emissions. These legal battles are forcing corporations to answer for their deception and could set precedents for holding polluters financially responsible for the destruction they cause.

At the international level, courts are also playing a crucial role. Last year's Advisory Opinion from the International Tribunal for the Law of the Sea (2024) noted that heat-trapping emissions are pollution that drives climate change and that nations have a duty under international law to take action to reduce the detrimental impacts of these emissions. A pending opinion from the International Court of Justice will clarify the obligations of governments to protect the climate system and may establish legal consequences for excessive heat-trapping gases. While the court ruling will focus on the responsibility of nations, it could also reinforce broader efforts to hold major fossil fuel producers accountable.

Multilateral Negotiations and Global Actions

While legal cases challenge fossil fuel companies directly, multilateral climate negotiations provide an avenue for governments to demand corporate accountability on an international scale. Since 1995, negotiations under the UNFCCC have sought to curb emissions, but major fossil fuel companies have lobbied behind the scenes to protect profits, shift blame to individuals and governments, and weaken regulations (Brulle 2020).

These negotiations have established important mechanisms, like the Loss and Damage fund, to compensate climate-vulnerable nations for the harm they are already experiencing. However, current funding commitments are less than one-third of what scientific studies show developing countries will need (Kreibiehl et al. 2022). Ensuring that corporations contribute to climate finance (funding to support adaptation in the most climate-vulnerable countries) is a critical next step in holding them accountable.

The Paris Agreement, the most high-profile outcome of the UNFCCC negotiations, seeks to prevent global temperatures from rising higher than 1.5°C–2°C above preindustrial levels. Ten years after its signing, it continues to guide governments across the world. UNFCCC negotiations will continue to play a key role in addressing climate change in the future, as impacts accelerate and the gaps between countries becomes increasingly stark.

A Growing Global Movement for Justice

Across the world, advocates, impacted communities, and policymakers are demanding that corporate polluters be held accountable for their role in climate change. Among the international court opinions, lawsuits, and multilateral negotiations, the message is clear: Fossil fuel companies must be held responsible for the harm they have caused.

Communities, governments, and legal experts are pursuing a range of strategies to shift the financial and legal burdens away from impacted communities and onto the corporations that knowingly fueled climate change. In direct litigation, international negotiations, and regulatory action, corporate accountability cannot be ignored as part of comprehensive efforts to address climate change.

Methodology

UCS used a combination of data and modeling to quantify the amount of global average surface temperature increase and sea level rise attributable to emissions traced to the 122 largest fossil fuel producers and cement manufacturers. Previous UCS research has shown that the products of these companies have increased concentrations of heat-trapping gases and atmospheric temperatures, driven ocean acidification and sea level rise, and increased areas burned in wildfires (Ekwurzel et al. 2017; Licker et al. 2019; Dahl et al. 2023). Our new study builds on this work, using an expanded emissions dataset and a publicly available climate model, and extends the attribution of past emissions from the Carbon Majors to project future impacts (Sadai et al. 2025).

By removing the emissions traced to these major carbon producers at three key points in time, this research also modeled the outcome of earlier emissions reductions: In 1854, before fossil fuel combustion was widespread; in 1950, when fossil fuel companies first became aware of the risks their products posed to the climate (Franta 2018); and in 1990, at the start of the international efforts to confront climate change.

To accomplish this, UCS used the Carbon Majors database, a comprehensive accounting of scope 1 and scope 3 emissions traced to 122 investor-owned, state-owned, and nation-state entities between 1854 and 2022 (Bhatia et al. 2004; InfluenceMap 2024). This newly updated dataset builds on the original Carbon Majors database, published in 2014, which included emissions data for 90 entities (Heede 2014).

UCS used the Carbon Majors data within MAGICC7, a reduced complexity climate-carbon cycle model with a built-in sea level model that can project sea level responses from thermal expansion, changes in water stored on land and the melting of the Greenland and Antarctic ice sheets and global mountain glaciers (Meinshausen, Raper, and Wigley 2011; Nauels et al. 2017; Nauels et al. 2019). This model performs scenario-based future projections, allowing for an assessment of future sea level rise responses to heat-trapping emissions that have occurred in the past.

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Acknowledgments

This analysis was made possible by the generous support of Grantham Foundation for the Protection of the Environment, the Hitz Family Foundation, Rockefeller Family Fund, Zegar Family Foundation, and UCS members.

The authors thank peer reviewers who reviewed this publication in *Environmental Research Letters*. This factsheet benefited from the reviews and advice of many UCS colleagues, including Sarah Goodspeed, Kathy Mulvey, Pallavi Shrestha, Amanda Fencl, Chitra Kumar, Eric Schulz, Chris Bliss, Ashley Siefert Nunes, and Daela Taeoalii-Tipton. Finally the authors thank Cynthia DeRocco, Heather Tuttle, and Bryan Wadsworth for editing and publication support.

Organizational affiliations are listed for identification purposes only. The opinions expressed herein do not necessarily reflect those of the organizations that funded the work or the individuals who reviewed it. The Union of Concerned Scientists bears sole responsibility for the report's content.

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