Atlantic white cedars dying near the banks of the Bass River in New Jersey show wetland encroachment on forested areas. Photo credit: Ted Blanco/Climate Central.
Figure 8. Historical High Tide Flood Frequency (# of flood days) for Atlantic City, NJ (Sweet et al., 2018)
FIGURE 3
Change in New Jersey annual flood risk
Number of current properties at risk of annual flooding, by county, comparing sea levels in 1980 to sea levels today

<table>
<thead>
<tr>
<th>County</th>
<th>1980 Sea Levels</th>
<th>Current Sea Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumberland</td>
<td>964</td>
<td>1,118</td>
</tr>
<tr>
<td>Burlington</td>
<td>913</td>
<td>1,243</td>
</tr>
<tr>
<td>Camden</td>
<td>761</td>
<td>1,304</td>
</tr>
<tr>
<td>Gloucester</td>
<td>1,338</td>
<td>1,615</td>
</tr>
<tr>
<td>Salem</td>
<td>2,498</td>
<td></td>
</tr>
<tr>
<td>Monmouth</td>
<td>6,644</td>
<td>8,225</td>
</tr>
<tr>
<td>Atlantic</td>
<td></td>
<td>13,159</td>
</tr>
<tr>
<td>Cape May</td>
<td>16,221</td>
<td>19,232</td>
</tr>
<tr>
<td>Ocean</td>
<td>31,931</td>
<td></td>
</tr>
</tbody>
</table>

Source: Rhodium Group and First Street Foundation analysis
FIGURE 4
Mapping New Jersey flood risk
Percent of all buildings at risk of annual flooding, comparing sea levels in 1980 to sea levels today

1980 Sea Levels
- Cape May: 20.9%
- Atlantic: 7.9%
- Ocean: 8.6%
- Salem: 12.5%
- Cumberland: 2.4%
- Monmouth: 3.3%
- Gloucester: 1.6%
- Burlington: 0.7%

Current Sea Levels
- Cape May: 27.8%
- Atlantic: 13.4%
- Ocean: 14.3%
- Salem: 15.3%
- Cumberland: 2.8%
- Monmouth: 4.1%
- Gloucester: 1.9%
- Burlington: 0.9%

Source: Rhodium Group and First Street Foundation analysis
Prediction

Svante Arrhenius (1859-1927) calculated how much increases in atmospheric carbon dioxide would increase the global surface temperature.
Detection of change vs Attribution of the causes
Detection of change

“Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.” – IPCC 2013
Attribution

“It is extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century.”

*extremely likely = 95-100% probability of an outcome or result.
NJ SLR since 1911 =
~8 inches Global SLR + ~7 inches natural subsidence + ~3 inches groundwater withdrawal
United States Environmental Protection Agency

April 2020
EPA 430-F-20-002

To learn more about the inventory, visit www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks, or explore the data at https://cfpub.epa.gov/ghgdata/inventoryexplorer/.

*Percentages may not add to 100% due to independent rounding and the way the inventory quantifies U.S. territories (not shown) as a separate sector.
MAJOR CARBON PRODUCER AND GLOBAL CO₂ AND METHANE EMISSIONS

- Global emissions from fossil fuels & cement (CDIAC)
- Emissions sourced to top 90 major carbon producers (Heede 2013)
Production
Production

Combustion

\( \text{CO}_2 \)

\( \text{CH}_4 \)

\( \text{CO}_2 \)

\( \text{CO}_2 \)

\( \text{CH}_4 \)

\( \text{CO}_2 \)

\( \text{CO}_2 \)

\( \text{CO}_2 \)

\( \text{CO}_2 \)
Edwin L. Drake (right) at the drilling site—but not the original derrick of America's first commercial oil well of 1859, Titusville, Pennsylvania.
Early oil industry knowledge of CO₂ and global warming

To the Editor — In a seminal 1960 article in the journal *Tellus*, Charles Keeling reported that the concentration of atmospheric CO₂ at the South Pole was rising at a rate “nearly that to be expected from the [global] combustion of fossil fuel”. His measurements, begun in 1957, allowed him to start constructing the famous Keeling curve — the continuous, direct record of rising CO₂ levels around the globe caused primarily by the burning of fossil fuels. Yet archival documents show that even before Keeling published his measurements, oil industry leaders were aware that their products were causing CO₂ pollution to accumulate in the planet’s atmosphere in a potentially dangerous way.

Fig. 1 | Excerpt of research proposal to the API from Harrison Brown and colleagues in 1954. The proposal informed the API that fossil fuels had caused atmospheric CO₂ levels to rise by about 5% over the last 100 years. Image reproduced from ref. 2, Caltech Archives.

Benjamin Franta
Department of History, Stanford University, Stanford, CA, USA. e-mail: bafranta@stanford.edu

Published online: 19 November 2018
https://doi.org/10.1038/s41558-018-0349-9

Acknowledgements
This research was supported by the Center for Climate Integrity and the Stanford University Department of History. T. Boughton of the University of Wyoming is thanked for providing the image for Fig. 2.
Annual Global CO$_2$ Emissions from Fossil Fuel and Cement, 1751–2015

Data source: Boden, Marland, and Andres 2016; Image source: Union of Concerned Scientists
The rise in global atmospheric CO₂, surface temperature and sea level from emissions traced to major carbon producers

Ekwarzel, Boneham, Dalton, Heede, Mera, Allen & Frumhoff. 2017
Climatic Change

bit.ly/GAT_SLR
Attributing ocean acidification to major carbon producers

Licker, Ekwurzel, Doney Cooley, Lima, Heede and Frumhoff, 2019
Environmental Research Letters

1880-2015 emissions tied to 88 largest carbon producers contributed 59-60% of Atmospheric CO₂ rise

Ekurzel et al., 2017, Climatic Change
Licker et al., 2019, Environmental Research Letters

bit.ly/GAT_SLR
bit.ly/OA_CO2
1880-2015 emissions tied to 88 largest carbon producers contributed ~33-66% of global mean surface temperature rise.

Ekwurzel et al., 2017, Climatic Change
Licker et al., 2019, Environmental Research Letters
1880-2015 emissions tied to 88 largest carbon producers contributed ~20-51% of global sea level rise

Source: NOAA

Ekurzel et al., 2017, Climatic Change
Licker et al., 2019, Environmental Research Letters
Who pays for damages and adaptation?

A fire hydrant nearly covered with sand washed ashore is seen in the aftermath of Hurricane Sandy in Atlantic City, New Jersey, October 30, 2012. REUTERS/Tom Mihalek