Economic Risks of Climate Change
An American Prospectus

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www.climateprospectus.org
Overview
Global temperatures are rising...

Degrees Fahrenheit

95% Confidence interval
Global Average Temperature
...and we know the main reason why.

World primary energy use, 1850-2008

Figure 1.9  |  History of world primary energy use, by Source (in EJ). Source: updated from Nakicenovic et al., 1998 and Grubler, 2008.

Figure 1.10  |  Structural change in world primary energy (in percent). Source: updated from Nakicenovic et al., 1998 and Grubler, 2008.
We’ve changed the atmosphere in a way unprecedented in our species’ history.
An Independent Assessment for a Climate Risk Committee
Analytical Support for the Risky Business Project (riskybusiness.org)
Research approach

Spatial Empirical Adaptive Global-to-Local Assessment System (SEAGLAS)

- **Downscaled, probabilistic physical climate projections**
- **Impact estimates based on meta-analysis of econometric research**
- **Integrated economic analysis with CGE model, consideration of potential adaptations**
- **Complementary detailed sectoral models**

![Maps and graphs showing climate projections and impact estimates](image-url)
Scope of coverage
Far from comprehensive – focus on impacts quantifiable in a 1-year analysis
Physical Climate Projections
We can shape the path of future greenhouse gas emissions.

- **RCP8.5** ("Business as Usual: Our Current Path")
- **RCP6.0** ("Small emissions reduction")
- **RCP4.5** ("Medium emissions reduction")
- **RCP2.6** ("Large emissions reduction")
- **Historical** parts per million carbon dioxide concentrations
Those choices affect the future temperature trajectory of the planet.

Temperature projections (°F) from the MAGICC simple climate model, courtesy Malte Meinshausen
And of the United States.

Median and 1-in-20 chance summer temperature projections (°F)

RCP 8.5 (high emissions)
Average summer temperature in Maryland
Degrees Fahrenheit

Florida 1981-2010 average
South Carolina 1981-2010 average

1981-2010 average (74.5°)
Average winter temperature in Maryland

Degrees Fahrenheit

South Carolina 1981-2010 average

North Carolina 1981-2010 average

1981-2010 average (35.5°)

2020-2039

2040-2059

2080-2099

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Number of days above 95°F in Maryland
Average days/year, population-weighted

1981-2010 average (6.4)

S. Carolina 1981-2010 avg.
Number of freezing days in Maryland
Average days/year, population-weighted

1981-2010 average (90)

North Carolina 1981-2010 average

South Carolina 1981-2010 average

2020-2039    2040-2059    2080-2099
They will also affect precipitation.

Median projected % precipitation change, RCP 8.5 (high emissions) in 2080-2099. In the faded regions, an increase and a decrease are both about equally likely.
## ACP Humid Heat Stroke Index

“It’s not just the heat; it’s the humidity.”

<table>
<thead>
<tr>
<th>ACP HHSI</th>
<th>Peak Wet Bulb Temperature</th>
<th>Description (hottest part of day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>74°F-80°F</td>
<td>Uncomfortable. Typical of much of summer in the Southeast.</td>
</tr>
<tr>
<td>II</td>
<td>80°F-86°F</td>
<td>Dangerous. Typical of most humid parts of Texas and Louisiana in hottest summer month, and most humid summer days in Washington and Chicago.</td>
</tr>
<tr>
<td>III</td>
<td>86°F-92°F</td>
<td>Extremely dangerous. Comparable to Midwest during peak days of 1995 heat wave.</td>
</tr>
<tr>
<td>IV</td>
<td>&gt;92°F</td>
<td>Extraordinarily dangerous. Exceeds all U.S. historical records. Heat stroke likely for fit individuals after less than one hour of moderate activity in the shade.</td>
</tr>
</tbody>
</table>
They will also affect humidity extremes.

**Expected number of Category 3+ (extremely dangerous) in a typical year**
Number of dangerously humid (Category II+) days in average Maryland summer

1981-2010 average (1.4)
Number of extremely dangerously humid (Category III+) days in average Maryland summer

(Note logarithmic scale!)
They also drive rising sea levels, both globally...

Feet global mean sea-level rise above year 2000 levels

RCP 2.6/8.5, 1-in-200 chance:
- 2030: 0.7 ft
- 2050: 1.4/1.6 ft
- 2100: 4.6/5.8 ft

Full analysis in Kopp et al. (2014), Earth’s Future
Sea-level rise in enhanced in Maryland due to the ongoing response to the end of the last ice age, changes in the Gulf Stream, and the gravitational and rotational effects of Antarctic mass loss.

...and here in Maryland.

Feet Baltimore sea-level rise above year 2000 levels

RCP 2.6/8.5, 1-in-200 chance:
- 2030: 1.2 ft
- 2050: 2.1/2.3 ft
- 2100: 5.6/6.8 ft
Economic projections
Research approach
Spatial Empirical Adaptive Global-to-Local Assessment System (SEAGLAS)

Downscaled, probabilistic physical climate projections

Impact estimates based on meta-analysis of econometric research

Integrated economic analysis with CGE model, consideration of potential adaptations

Complementary detailed sectoral models
Climate change will have unevenly distributed economic impacts.
Energy demand
% increase in annual residential + commercial energy expenditures

Impact function calibrated against RHG–National Energy Modeling System

Rutgers University | American Climate Prospectus: Economic Risks in the United States
Coastal impacts
Increased average annual coastal storm damage due to sea-level rise

Average annual coastal flood damage
RCP 8.5 2050 (percent increase by state)
(property + business interruption, in today’s economy)
Climate change will make extremes more commonplace.

Expected number of extreme fatal heat waves nationally

- **1-in-2 year event**
- **1-in-5 year event**
- **1-in-10 year event**

<table>
<thead>
<tr>
<th>Beginning of 20-year interval</th>
<th>Historic</th>
<th>RCP 2.6</th>
<th>RCP 4.5</th>
<th>RCP 8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
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<tr>
<td>2020</td>
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<td>2080</td>
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</table>

Number of extreme years per 20 years
Climate change will make extremes more commonplace.

Expected number of extreme low-productivity heat waves nationally

<table>
<thead>
<tr>
<th>Beginning of 20-year interval</th>
<th>Historic</th>
<th>RCP 2.6</th>
<th>RCP 4.5</th>
<th>RCP 8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2020</td>
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<td>2040</td>
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<td>2060</td>
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<td>2080</td>
<td>0</td>
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</table>

- 1-in-2 year event
- 1-in-5 year event
- 1-in-10 year event

Graph showing expected number of extreme events per 20 years with RCP 2.6, RCP 4.5, and RCP 8.5 scenarios compared to historic data.
Climate change will make extremes more commonplace.

Expected number of extreme crop loss events nationally

Number of extreme years per 20 years

Beginning of 20-year interval
Climate change will make extremes more commonplace.

Expected number of extremely damaging ($100B) hurricanes nationally
(accounting only for sea-level rise, not storm changes)

![Graph showing expected number of extremely damaging hurricanes]

- **Historic**: 0.5 hurricanes per 20 years
- **RCP 2.6**: 1 hurricane per 20 years
- **RCP 4.5**: 1.5 hurricanes per 20 years
- **RCP 8.5**: 2 hurricanes per 20 years
Our mitigation choices make a real difference – but we will have to prepare for some impacts even under low emissions.
Total cost and sectoral breakdown differ by region

RCP 8.5, median case, 2080-2099, % of GSP
Maryland is slightly less exposed than national average.  
RCP 8.5, median case, 2080-2099, % of GSP

<table>
<thead>
<tr>
<th>State</th>
<th>Coastal (Historical Activity)</th>
<th>Agriculture</th>
<th>Labor</th>
<th>Energy</th>
<th>Crime</th>
<th>Mortality (Income)</th>
<th>Mortality (VSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
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<td>Maryland</td>
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<td>Delaware</td>
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<td>Georgia</td>
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<tr>
<td>Florida</td>
<td>12%</td>
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</tbody>
</table>

-2%  0%  2%  4%  6%  8%  10%  12%  14%
Direct damages in Maryland as % of GSP
RCP 8.5, 2080-2099
Increased mortality in Maryland
Additional annual deaths per 100,000

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Total Annual Deaths Assuming Current Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020-2039</td>
<td>8.5</td>
</tr>
<tr>
<td>2040-2059</td>
<td>4.5</td>
</tr>
<tr>
<td>2080-2099</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Note: The chart shows the projected additional annual deaths per 100,000 population in Maryland due to climate change, with projections for the periods 2020-2039, 2040-2059, and 2080-2099.
Decreased labor productivity in high-risk sectors (~20% of workers) in Maryland
Increased residential & commercial energy expenditures in Maryland

% above year 2012 base ($9.0 billion)
Increased average annual coastal storm damage
Million dollars per year (assuming current property distribution)

2000 baseline: $197 million

Diamonds indicate 99th percentile (1-in-100) projection.
Reminder: Scope of coverage

Far from comprehensive – focus on impacts quantifiable in a 1-year analysis
Take-aways

- By 2040-2059 under RCP 8.5, median projected summer temperature in Maryland will be comparable to that in Georgia today; the expected number of dangerously humid days will exceed those of Mississippi today.

- Economic impacts are unevenly distributed across the country, with Maryland losses close to but slightly below national average.

- Of impacts examined, in Maryland, labor productivity, mortality, and energy demand are the largest by late century.

- Median projected increase in Maryland deaths under RCP 8.5, 2080-2099, is about 7 per 100,000 (about 400 additional people in current Maryland population), similar to current homicide rate.

- Mitigation benefits largest and most certain for labor, mortality, energy, and crime. Agriculture benefits less clear because of carbon fertilization; coastal because of slow response of the system.
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