Impacts, Risks, and Adaptation in a Changing Climate: An Overview of the Fourth National Climate Assessment

Benjamin DeAngelo
Deputy Director, Climate Program Office
NOAA Oceanic & Atmospheric Research

18 June 2019
Legislative mandate: U.S. Global Change Research Program

- USGCRP began as a Presidential initiative in 1989
- Mandated by Congress in the U.S. Global Change Research Act (GCRA) of 1990 “to assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change”
- Overseen by Principals representing the 13 member agencies of the Committee on Environment’s Subcommittee on Global Change Research (SGCR)
Legislative mandate for a quadrennial NCA

Global Change Research Act of 1990, Section 106:

Not less frequently than every 4 years [USGCRP] shall prepare and submit to the President and Congress an assessment which:

• Integrates, evaluates, and interprets the findings of [USGCRP] and discusses the scientific uncertainties associated with such findings

• Analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity

• Analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.
Multiple points of federal review and decision (orange icons) were present throughout the process.

In addition, public engagement (blue icons) was a cornerstone of the NCA4 development process.

Authors used these feedback mechanisms to inform their chapter’s development (black icons).
# NCA4: a two-volume effort

<table>
<thead>
<tr>
<th>Congressional Mandate</th>
<th>Fourth National Climate Assessment (NCA4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vol I: Climate Science Special Report</td>
</tr>
<tr>
<td></td>
<td>Vol II: Impacts, Risks, and Adaptation in the U.S.</td>
</tr>
<tr>
<td>Integrates, evaluates, and interprets the findings of the Program (USGCRP) and</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td>discusses the scientific uncertainties associated with such findings</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td></td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td>Analyzes the effects of global change on the natural environment, agriculture,</td>
<td></td>
</tr>
<tr>
<td>energy production and use, land and water resources, transportation, human health</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td>and welfare, human social systems, and biological diversity</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td></td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td>Analyzes current trends in global change, both human-induced and natural, and</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
<tr>
<td>projects major trends for the subsequent 25 to 100 years.</td>
<td><img src="https://example.com/%E2%9C%94%EF%B8%8F" alt="✔️" /></td>
</tr>
</tbody>
</table>
NCA4 Vol II: *Impacts, Risks, & Adaptation in the United States*

- Released Nov 23, 2018
- **Policy relevant**, but not policy prescriptive
- Places a strong emphasis on **regional information**
- Quantifies some **impacts in economic terms**
- Integrates **international** considerations
- Assesses a **range of potential impacts**, helping decision makers better identify risks that could be avoided or reduced
- Uses **case studies** to provide additional context and to showcase community success stories

Read and download the report at [nca2018.globalchange.gov](http://nca2018.globalchange.gov)
Table of Contents

I. Overview
II. Our Changing Climate
III. National Topics
   • Water
   • Energy Supply, Delivery and Demand
   • Land Cover and Land-Use Change
   • Forests
   • Ecosystems, Ecosystem Services, and Biodiversity
   • Coastal Effects
   • Oceans and Marine Resources
   • Agriculture and Rural Communities
   • Built Environment, Urban Systems, and Cities
   • Transportation
   • Air Quality
   • Human Health
   • Tribes and Indigenous Peoples
   • Climate Effects on U.S. International Interests
   • Sector Interactions, Multiple Stressors, and Complex Systems
IV. Regional Chapters
   • Northeast
   • Southeast
   • U.S. Caribbean
   • Midwest
   • Northern Great Plains
   • Southern Great Plains
   • Northwest
   • Southwest
   • Alaska
   • Hawai`i and U.S.-Affiliated Pacific Islands
V. Response
   • Reducing Risks Through Adaptation Actions
   • Reducing Risks Through Emissions Mitigation
VI. Appendices
   • Process
   • Information Quality Act
   • Data Tools and Scenarios
   • International
   • Frequently Asked Questions
Observed Change
Temperatures globally continue to change rapidly

- Since NCA3 was published, the global, long-term, and unambiguous warming trend has continued.
- 2016 was the warmest year on record, 2015 is 2\textsuperscript{nd} and far surpassed 2014, which is 3\textsuperscript{rd}.
- Since 2000, 16 of the 17 years warmest years on record have occurred.
- Global average temperature has increased by about 1.8°F from 1901 to 2016.
Diminishing Arctic sea ice
Diminishing Arctic sea ice

Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)

Steffen Olsen, an Arctic researcher with the Danish Meteorological Institute, and dogs set out to retrieve oceanographic moorings and a weather station over meltwater topping sea ice in northwest Greenland on Thursday. (Steffen Olsen)

By Jason Samenow
June 14
Attribution of Change
Climate will Continue to Change: NCA4 future projections primarily based on widely-used RCP scenarios
Projected Change: Temperature & Precipitation

Areas with red dots show where projected changes are large compared to natural variations; areas that are hatched show where changes are small and relatively insignificant.
Projected Changes in Number of Days >90°F and <32°F for 2036-2065 relative to 1976-2005 for a High Emissions Scenario
Sea Level Rise (in 2100 vs. 2000)

Lower Scenario (RCP4.5)

Higher Scenario (RCP8.5)

Relative Sea Level Change (feet)

-6 -4 -2 0 2 4 6

Thermal Expansion + Land-Based Ice Melt + Vertical Land Movement + Ocean Circulation...
**Human health**: increases in heat-related deaths projected to outweigh reductions in cold-related deaths.
Air quality: climate impacts on ozone

- Nationally, ozone concentrations have been reduced by 22% over the 1990 to 2016 period
- Nonetheless, in 2015 nearly 1 in 3 Americans were exposed to ozone values that exceeded the national standard determined by EPA to be protective of human health
- There is high confidence that climate change will increase ozone levels over much of the United States, particularly over already polluted areas
- This climate penalty will partially counteract the continued reductions in emissions of ozone precursors from human activities
Air quality: climate impacts on particulate matter?

• PM$_{2.5}$ accounts for most of the health impacts due to air pollution in the United States

• Without consideration of climate effects, concentrations of PM$_{2.5}$ in the United States are projected to decline through 2040 due to ongoing emissions control efforts

• PM$_{2.5}$ is highly sensitive to weather conditions

• Accordingly, the net impact of climate-driven weather changes on PM$_{2.5}$ concentrations is less certain than for ozone.
Food production: risks are highly regional, as is ability of producers to adapt

- Any change in the climate poses a major challenge to agriculture
- Important for rural communities
- Producers have options to adapt
- Extended growing season can have positive effects, but net effect of changing climate is multifaceted
Coastal effects: sea-level rise is amplifying impacts from storm surge and high tides

- As of 2013, coastal shoreline counties were home to 133.2 million people, or 42% of the population.
- Threats from SLR are exacerbated by dynamic processes such as high tide and storm surge flooding.
- This figure shows that cumulative damages (in 2015 dollars) to coastal property across the contiguous U.S. would be significantly reduced if protective adaptation measures were implemented.
Multi-sector analyses of monetary costs, and implications of future scenario

- The total area of each circle represents the projected annual economic damages under a higher warming scenario (RCP8.5) in 2090 relative to a no-change scenario.

- The decrease in damages under a lower warming scenario (RCP4.5) compared to RCP8.5 is shown in the lighter-shaded area of each circle.
Northeast: changing seasonality

- The seasonality of the Northeast is central to the region’s sense of place and is an important driver of rural economies.
- Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry.
- The region’s rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow.

Fig 18.3 - Lengthening of the freeze-free period
Alaska: temperature changes, permafrost thaw, indigenous peoples

- Alaska residents, communities, and their infrastructure continue to be affected by permafrost thaw, coastal and river erosion, increasing wildfire, and glacier melt. These changes are expected to continue into the future with increasing temperatures.

- The subsistence activities, culture, health, and infrastructure of Alaska’s Indigenous peoples and communities are subject to a variety of impacts, many of which are expected to increase in the future.
Reducing Risks Through Adaptation Action

- Adaptation is an ongoing, iterative process
- Since NCA3, the scale and scope of adaptation implementation has increased
- It remains difficult to tally the extent of adaptation implementation since there are no common reporting systems, and many actions that reduce climate risk are not labeled as climate adaptation
- Enough is known, however, to conclude that adaptation implementation is neither uniform nor commonplace across the U.S.
Nearly linear relationship between cumulative CO₂ emissions and global mean temperature increases

Source: IPCC 2013
THANK YOU!

Ben DeAngelo
ben.deangelo@noaa.gov

Thank you to the hundreds of volunteer federal and non-federal authors, editors, and technical contributors to NCA4

nca2018.globalchange.gov