Curriculum connector

Environmental Justice

Our changing environment and justice for all

The Earth's climate is constantly changing, resulting in extreme changes to our weather, ecosystems, oceans, and much more. Students will use data sets and graphs to examine the effects of climate change on life on Earth. Particular attention will be focused on environmental justice for all populations. The United States Environmental Protection Agency defines environmental justice as, "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies."[1]

Effects of climate change on vulnerable communities

Climate change has many impacts, such as rising temperature and sea levels. These elements have catastrophic effects on our planet, and also disproportionately impact vulnerable communities. Students will use data to identify marginalized populations that are living in possible high-impact areas. They will also explore how to use data to determine what changes need to occur to protect these vulnerable communities from the impacts of climate change.

NASA: Global climate change

Vital Signs of the Planet, NASA

Activity idea #1: Examine the Earth's vital signs related to climate change. Six different sets of data are included that focus on carbon dioxide, global temperatures, Arctic Sea ice extent, ice sheet, sea level, and ocean heat content. If possible, visit the interactive graphs for the ability to zoom in on a specific area of the graph as well as identify specific dates and the associated data. Create a data table to show the comparisons of data across the various vital signs for specific years. Focus on the organization of the data and use appropriate headings. Lastly, identify one overarching takeaway to summarize the data content.

Activity idea #2: Digitally, or by hand, recreate two graphs on the same coordinate plane with the data content overlapped on each other (similar to creating two layers). Be sure to place the years on the x-axis and each of the two different units of measurement on both y-axes on the left and right sides of the graph. Once the two sets of data are on the same graph, look for correlations and other observations that can be made from the joined sets of data. Then use the percent change formula to identify how each of your selected vital signs have changed between two points in time. Organize these percent of changes into a data table and identify two to three overarching takeaways to summarize the data content.

1 Environmental Protection Agency, https://www.epa.gov/environmentaljustice/learn-about-environmental-justice#:~:text=Environmental%20justice%20(EJ)%20is%20the,environmental%20laws%2C%20regulations%20and%20policies.

Connects to:

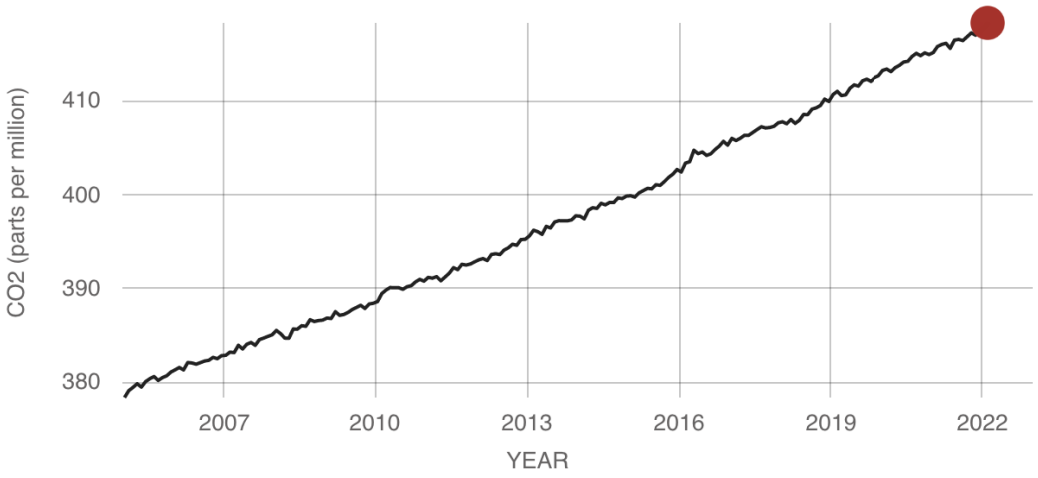
- Career pathways:
  - Environmental biologists and engineers
  - Statistical analysis
  - Science, Technology, Engineering & Mathematics
- National standards:
  - Using data to draw inferences
  - Analyzing data
  - Posing questions
  - Evaluating claims

Visual/Graphic: NASA, Vital Signs of the Planet. Charts and graphs are provided below for settings without internet access.

Carbon dioxide

DIRECT MEASUREMENTS: 2005-PRESENT

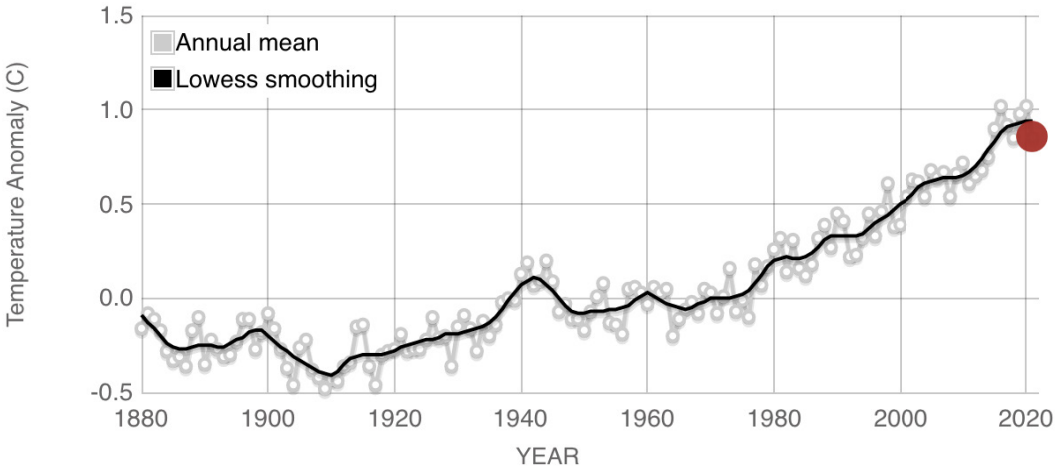
Data source: Monthly measurements (average seasonal cycle removed). Credit: NOAA



Global temperatures

GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS).
Credit: NASA/GISS



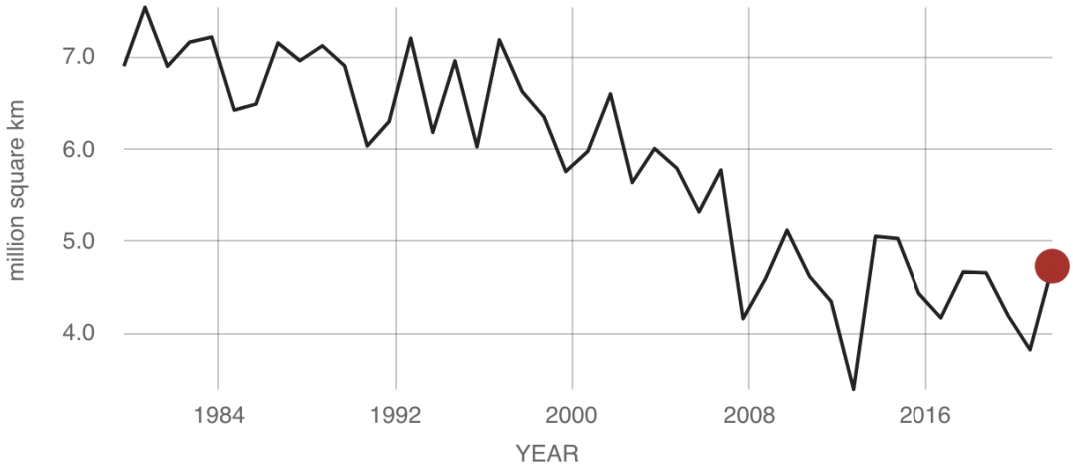
Arctic sea ice extent

ANNUAL SEPTEMBER MINIMUM EXTENT

Data source: Satellite observations. Credit: NSIDC/NASA

RATE OF CHANGE

↓ 13.0
percent per decade



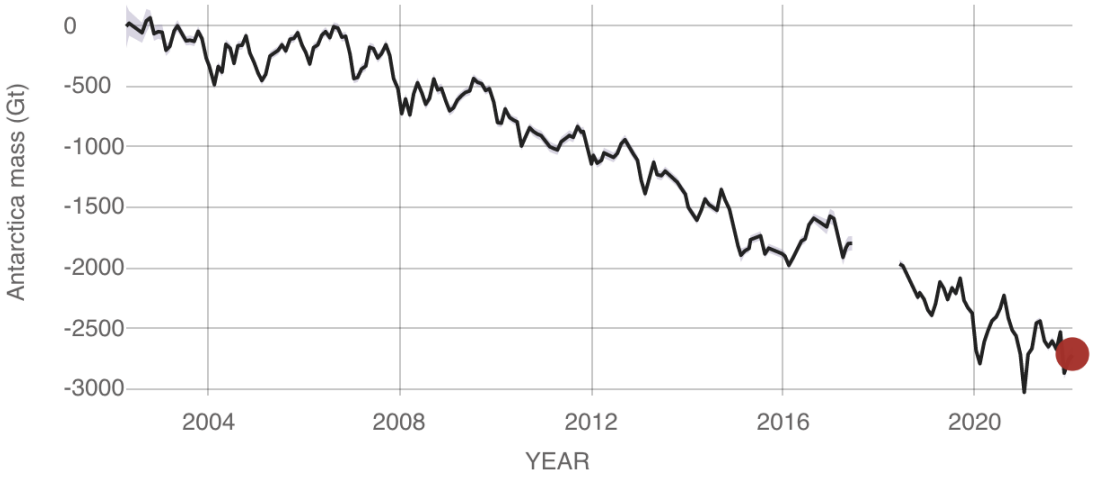
Global temperatures[2]

ANTARCTICA MASS VARIATION SINCE 2002

Data source: Ice mass measurement by NASA's GRACE satellites.
Gap represents time between missions.
Credit: NASA

RATE OF CHANGE

↓ 152.0
billion metric tons per year since 2002

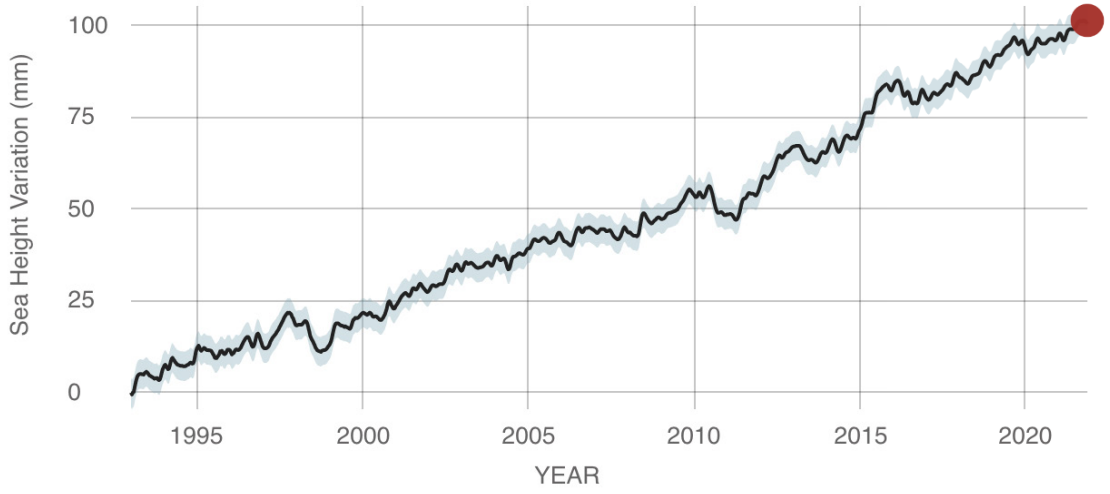


SATELLITE DATA: 1993-PRESENT

Data source: Satellite sea level observations.
Credit: NASA's Goddard Space Flight Center

RISE SINCE 1993

↑ 101.2
millimeters

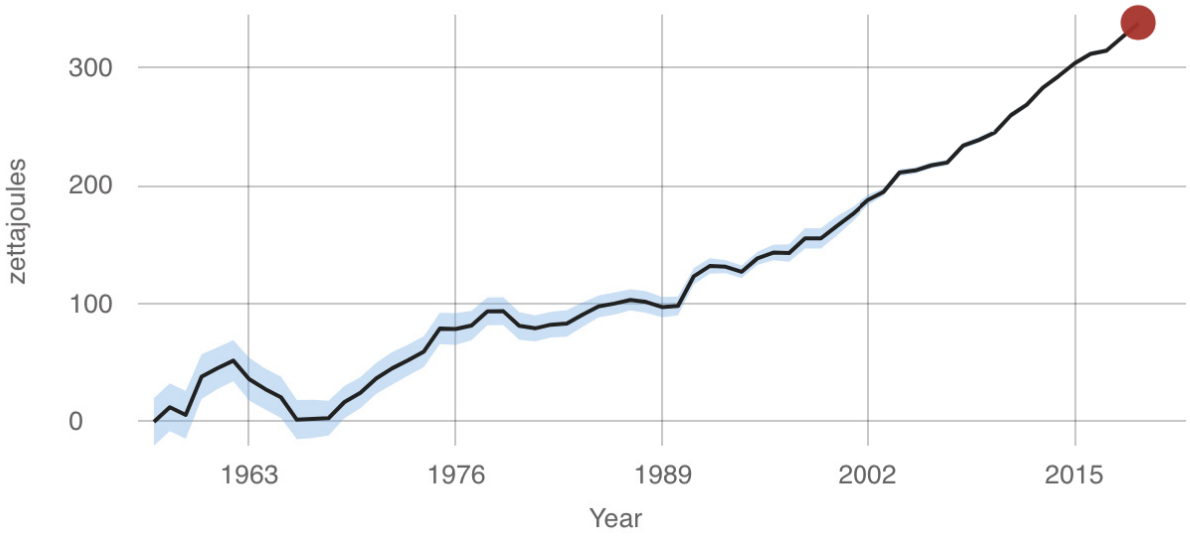


2 **Please note:** There is a break in the graph.

Ocean heat content

OCEAN HEAT CONTENT CHANGES SINCE 1955 (NOAA)

Data source: Observations from various ocean measurement devices, including conductivity-temperature-depth instruments (CTDs), Argo profiling floats, and eXpendable BathyThermographs (XBTs). Credit: NOAA/NCEI World Ocean Database



Explore the portrait of a highly vulnerable community and the impact of climate change
Climate Change and Social Vulnerability in the United States, Environmental Protection Agency

Activity idea #1: Select one of the four identified socially vulnerable populations (low income, minority, no high school diploma, and 65 and older) and analyze the graphical map data to create a portrait of how that community is impacted by climate change. Create a visual presentation that incorporates graphs and data tables that identifies correlations among the data sets.

Activity idea #2: Select two cities that vary regarding how they are impacted by climate change. For example, students may select Washington D.C. and San Francisco to examine the difference between East and West Coast cities. Collect, analyze, and depict bivariate data that compares and contrasts the significance of location upon the four identified socially vulnerable communities. Information within the linked report can also be useful to describe how these vulnerable groups are impacted differently because of location.

Connects to:

- Career pathways:
    - Environmental biologists and engineers
    - Statistical analysis
    - Science, Technology, Engineering & Mathematics (S.T.E.M.)
    - Sociology
- National standards:
    - Using data to draw inferences
    - Analyzing data
    - Posing questions
    - Evaluating claims

Visual/Graphic: EPA, Climate Change and Social Vulnerability in the United States. Charts and graphs are provided below for settings without internet access.

Figure 2.4 – Current Distribution of Socially Vulnerable Populations by Census Tract

Data from the U.S. Census Bureau's 2014-2018 American Community Survey.

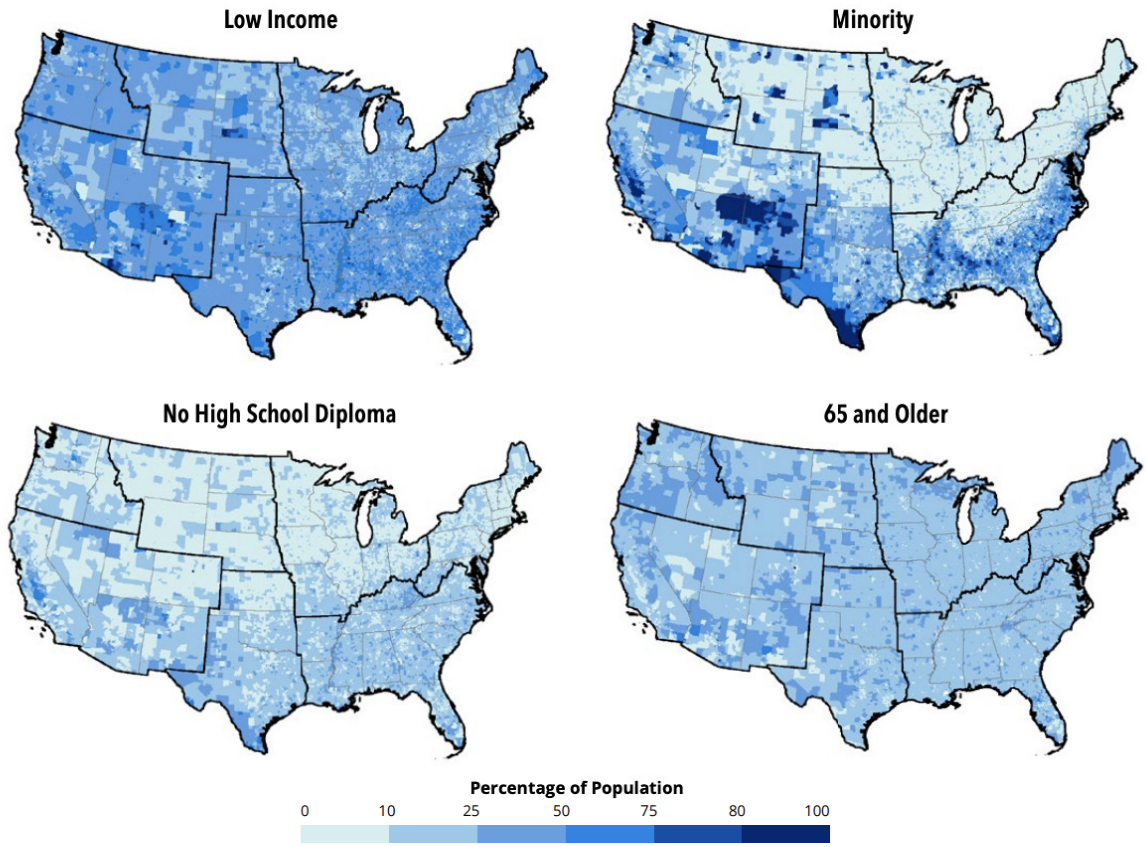


Figure 3.1 – Projected Changes in Annual Premature Deaths due to Climate-Driven Effects on $PM_{2.5}$

The analysis estimates changes in premature deaths among people ages 65 and older at the Census tract level. Levels of global warming are relative to the 1986-2005 average.

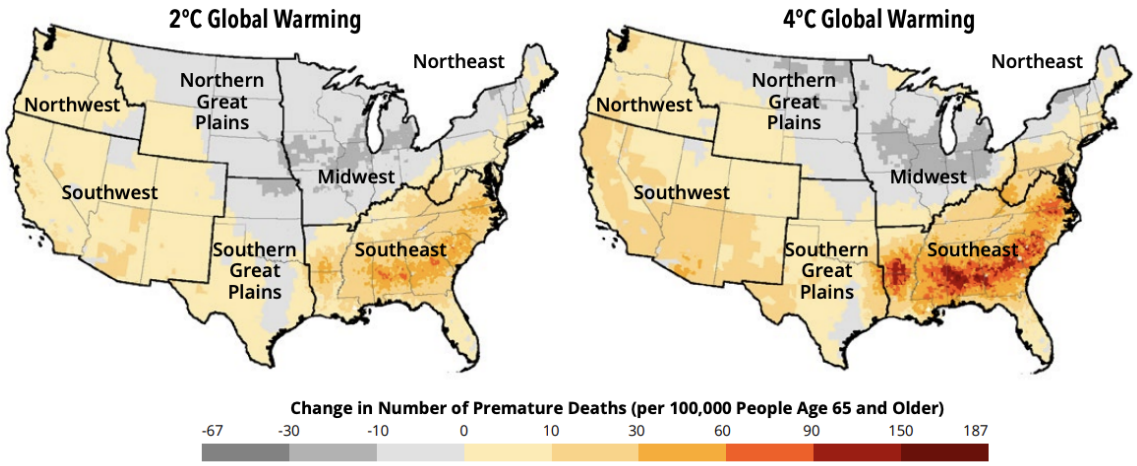


Figure 4.2 – Projected Increase in Annual Premature Mortality Rates due to Extreme Temperatures

Levels of global warming are relative to the 1986-2005 average. Results are calculated for each of the 49 cities included in the analysis (see Figure 4.1). Importantly, cities that are not included in the analysis may still experience significant temperature mortality impacts from climate change.

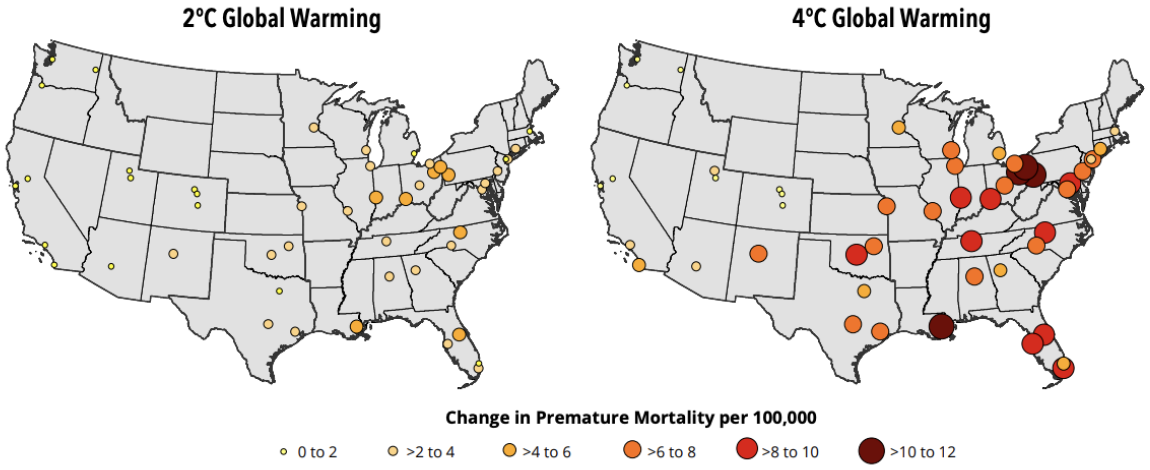


Figure 5.1 – Projected Labor Hours Lost Each Year due to Climate Change

Levels of global warming are relative to the 1986-2005 average. Results are calculated at the Census tract level.

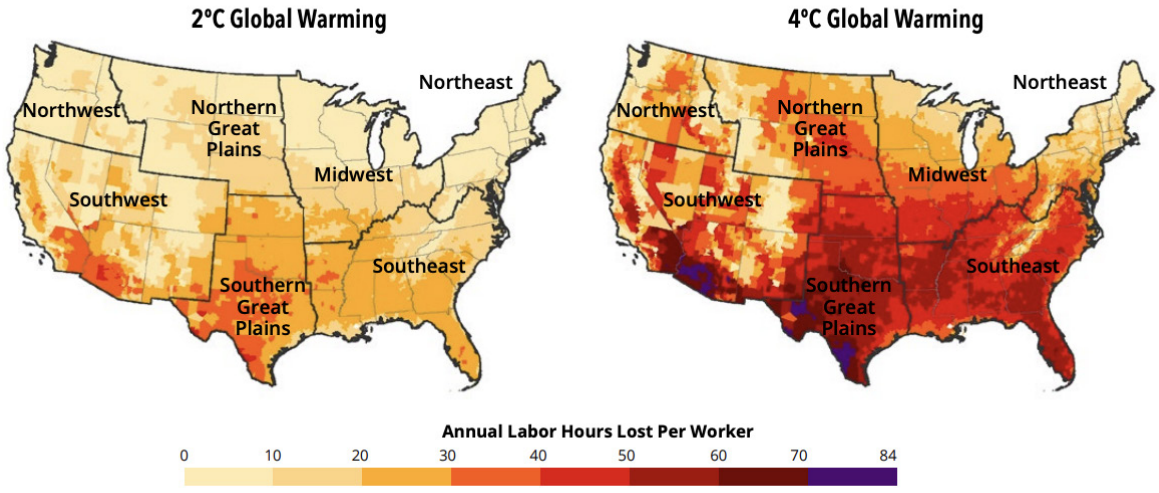


Figure 6.1 – Projected Traffic Delays from High-Tide Flooding in Coastal Areas (Hours Per Person Per Year)

Levels of global sea level rise are relative to the year 2000. The map shows the coastal regions included in the analysis, but does not show the specific areas projected to experience high-tide flooding traffic delays.

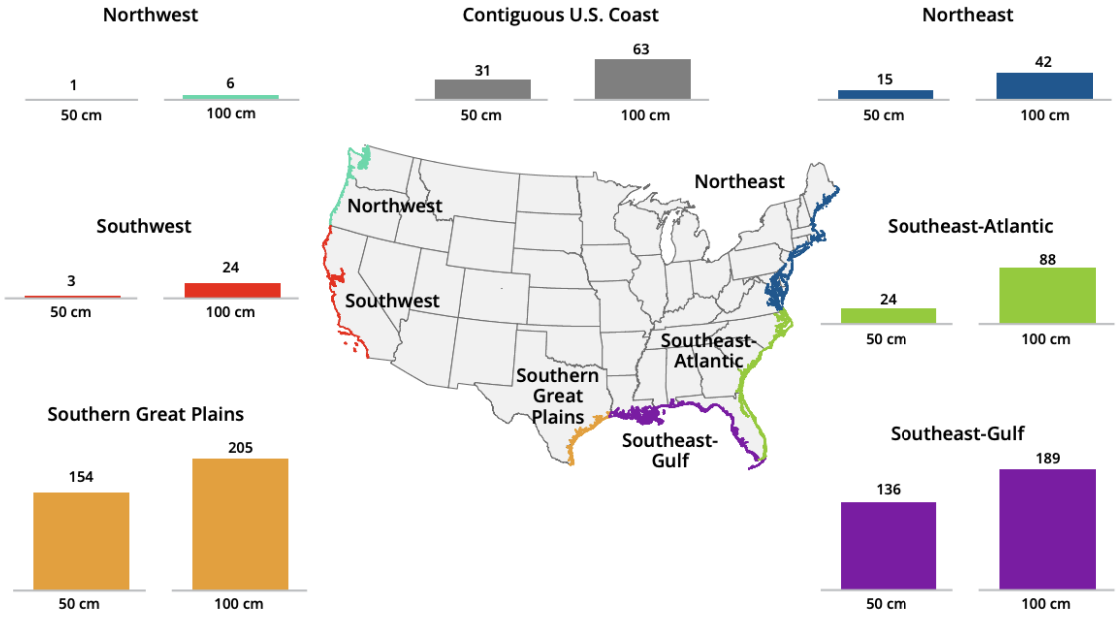


Figure 7.1 – Current Distribution of Socially Vulnerable Populations in the Coastal Counties of the Contiguous U.S.

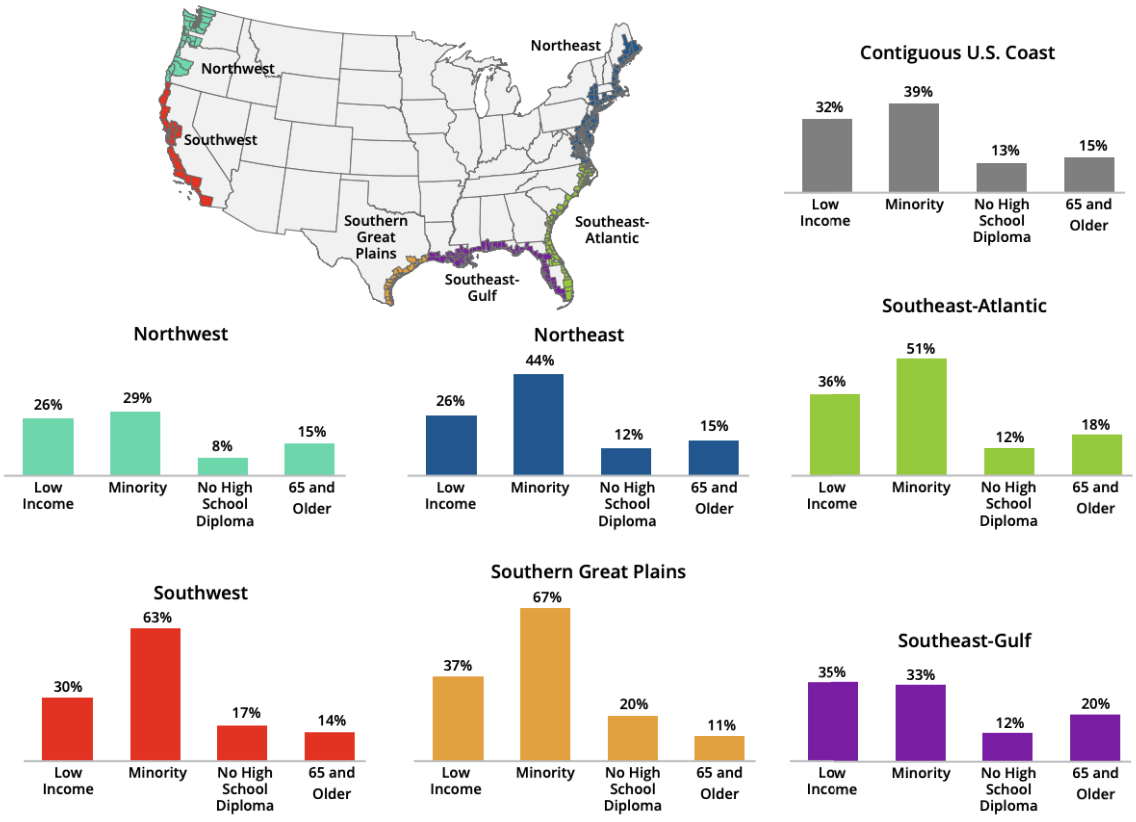
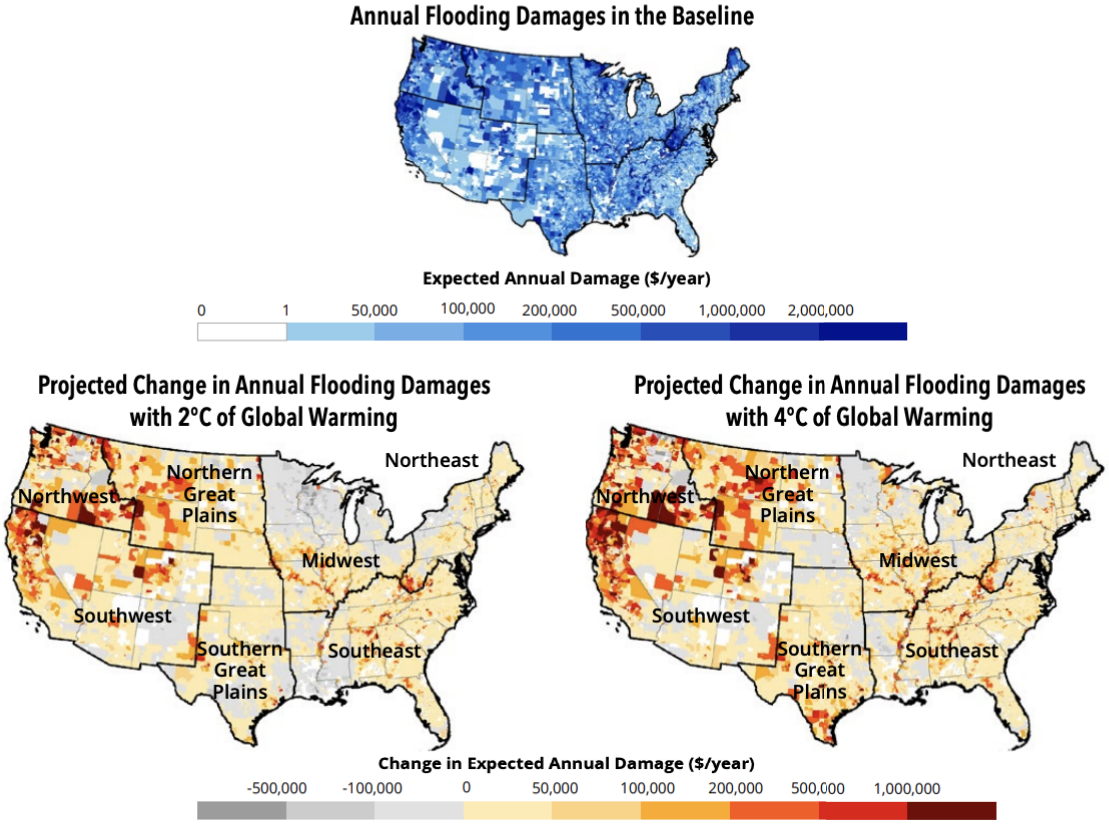


Figure 8.1 – Expected Annual Damages from Inland Flooding

Levels of global warming are relative to the 2001-2020 average.[24] Values represent average damages per year at the Census tract level. Census tracts in white are those that are outside of the 500-year floodplain or in the coastal floodplain and are therefore not included in the analysis. The changes in expected annual damages are relative to the baseline.



Discover climate change projections and solutions

Future Greenhouse Gas Emissions, Our World in Data, and Table of Solutions, Project Drawdown

Activity idea #1: What can be done to reduce the impacts of climate change and its impacts on vulnerable communities, in pursuit of environmental justice? Use the Future Greenhouse Gas Emissions graph on the next page to make 5 to 7 claims that can be made by observing the data provided. Analyze the trajectory of our future planet based upon different forms of mitigation. Then engage in small group and/or class discussion(s) to explore the projected impact to greenhouse gas emissions depending upon the potential future scenarios.

Activity idea #2: Use the interactive Table of Solutions to explore the potential impacts each climate change solution has on projected global emissions. Click on several of the solutions and take time to consider the statistical impacts of each. Then, select one sector such as transportation, industry, electricity, or any of the other identified areas. Next, select 5 different solutions within your chosen sector. Gather the data into a table or graphical representation using a color-coded key so that the projected mitigation efforts can be compared and contrasted. Lastly, share the findings and engage in discussion about what people think should be prioritized to reduce the effects on vulnerable communities. **Teacher note:** *Before starting the activity, you might ask students to identify a sector of greatest interest. This could help to evenly distribute the sectors so that all areas will be considered on behalf of the whole class.*

Connects to:

- Career pathways:
    - Environmental biologists and engineers
    - Statistical analysis
    - Science, Technology, Engineering & Mathematics (S.T.E.M.)
- National standards:
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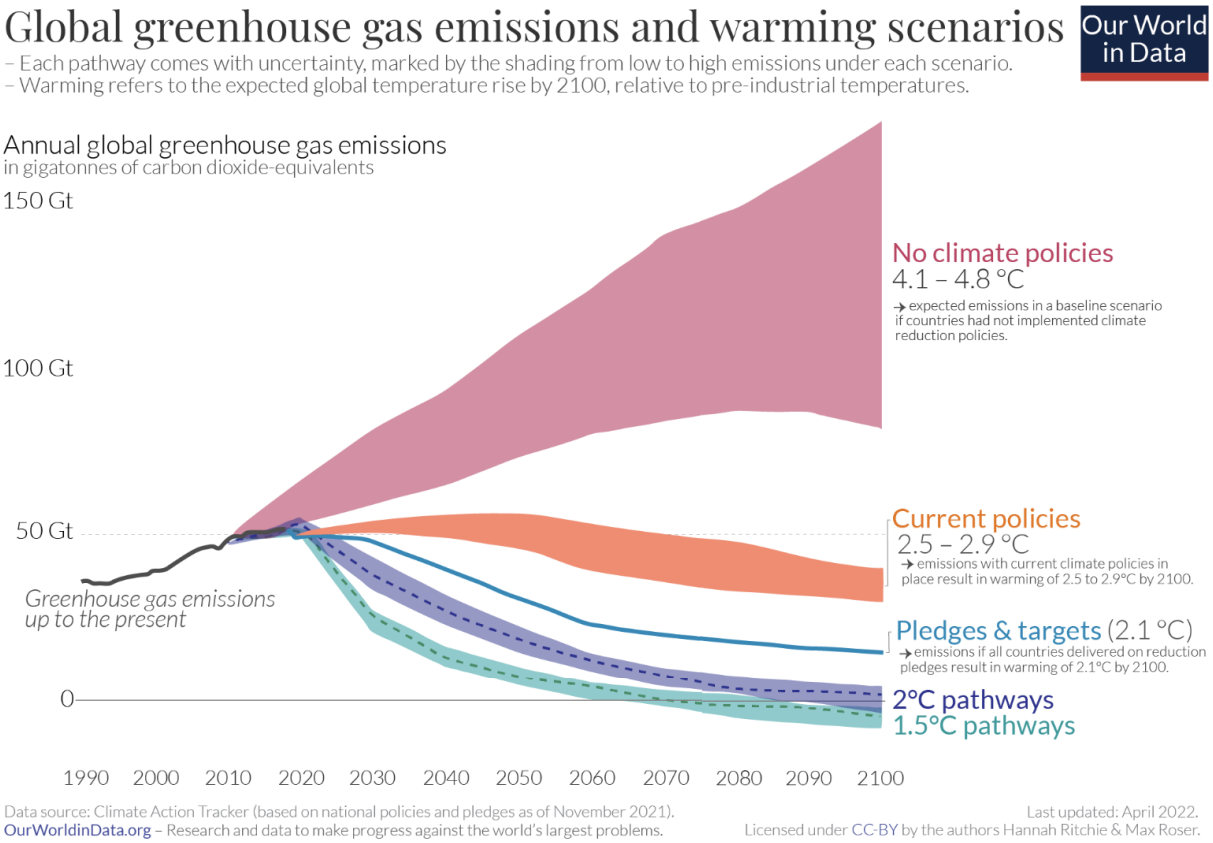
    - Analyzing data
    - Posing questions
    - Evaluating claims

Visual/Graphic: Our World in Data, Future Greenhouse Gas Emissions and Project Drawdown, Table of Solutions. Charts and graphs are provided below for settings without internet access.



https://ourworldindata.org/future-emissions

Please note: *The Table of Solutions data has not been included here due to the interactive nature of the platform.*

Collecting data—to solve a problem, you need to find the right information.

Watch the introductory video on Steps to Resilience from the United States Global Change Research Program, managed by the National Oceanic and Atmospheric Administration (NOAA). Follow that video up by watching this brief video on Assessing Vulnerability and Risk. You may optionally choose to watch all the videos within the Steps to Resilience framework; however, it is not necessary to complete this extension activity. Note for your students that, "Communities, businesses, and individuals are taking action to document their vulnerabilities and build resilience to climate-related impacts."[3] To further understand resilience in action, use the drop-down menus at the top of the U.S. Climate Resilience Toolkit case study page to help guide your selection of a particular climate threat/stressor, climate-related topic, steps to resilience or a given region to explore a real-world case study of interest to you. Read the information provided within the case study and closely examine the data, graphs, and/or statistical information related to the case. Then create an interactive, digital summary that provides the key ideas of your selected case study.

3 U.S. Climate Resilience Toolkit, https://toolkit.climate.gov/case-studies

Key vocabulary:

bivariate data: two types of related data often used for identifying comparisons and correlations

case study: an in-depth look at a particular situation for research and learning purposes

climate stressor: an event, condition or trend that can exacerbate harmful conditions due to climate variability

conservation: preservation, protection, or restoration of the natural environment, natural ecosystems, vegetation, and wildlife

disproportionately: uneven or out of balance in comparison to something else

mitigation: reducing and stabilizing the levels of heat-trapping greenhouse gasses in the atmosphere

resilience: the capacity of a system (environment or community) to withstand, respond to, recover, and prevent future harmful conditions

vulnerable: capable of being physically or emotionally hurt

zettajoules: the SI unit of measurement for energy and work that is a factor of 10^{21}