



**National Oceanic and
Atmospheric Administration**

June 22, 2022

Climate Basics

FEMA Region X

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Questions to think about...

- What are your concerns about climate impacts?
- Who is your go-to climate resource?



Climate Basics

- The climate system
- Climate vs. Weather
- Climate variability and climate change
- Climate change and disaster risk in Region X



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The Climate System



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Why do we care?



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Weather vs Climate

- Weather refers to variations in the atmosphere for minutes to days
(AMS Glossary)
- Climate is what you expect,
weather is what you get



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Weather	Climate
What you wear each day 	What you wear over the year 

<https://letstalkscience.ca/educational-resources/backgrounders/introduction-climate-change>



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Climate Variability

- Natural changes in climate that fall within the observed range of extremes for a particular region (USGCRP 2017)
- The “wiggles” in climate conditions



What is “climate change” ?

Changes in average weather conditions that persist over multiple decades or longer
(USGCRP 2017)



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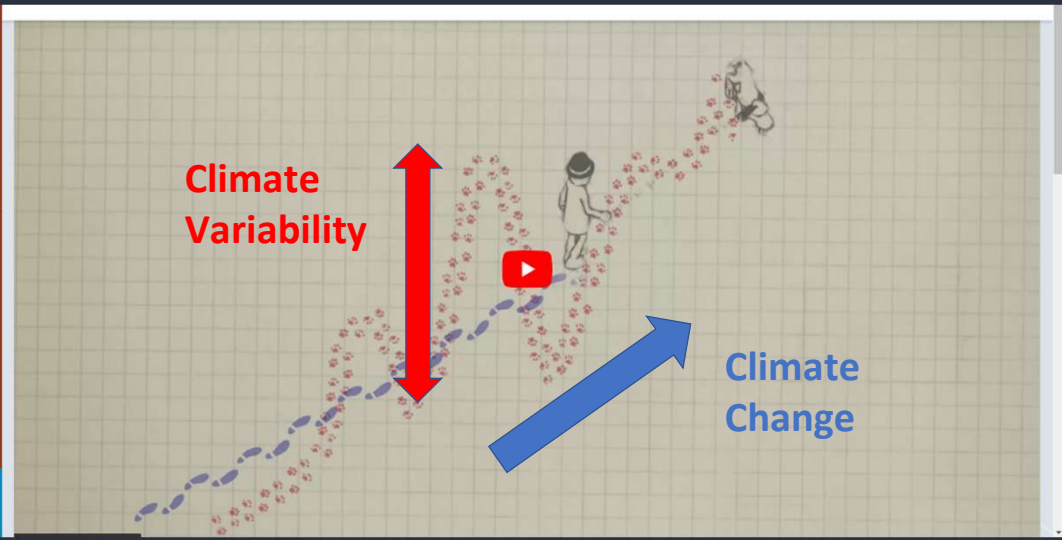
<https://youtu.be/e0vj-0imOLw>



<https://scied.ucar.edu/video/dog-walking-weather-and-climate>
Credit: Siffer, produced by TeddyTV for NRK. Animation by Ole Christoffer Haga

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Climate Variability

Climate Change

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We manage BOTH climate change and variability

- Weather/climate disaster events include elements of climate variability AND climate change
- “Attribution” can be helpful, but should not be a barrier for planning
- Past variability can be a good test of RESILIENCE in the face of future change



Climate change in the Pacific Northwest and Alaska

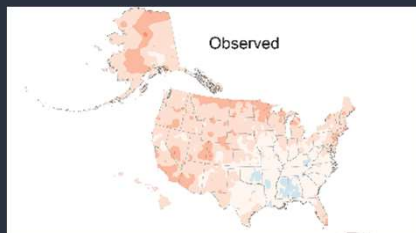
- Warming
- Sea level rise
- More frequent/intense heavy precipitation
- Less snow that melts earlier
- More intense drought impacts
- Loss of sea ice
- Loss of permafrost
- More frequent/intense wildfire



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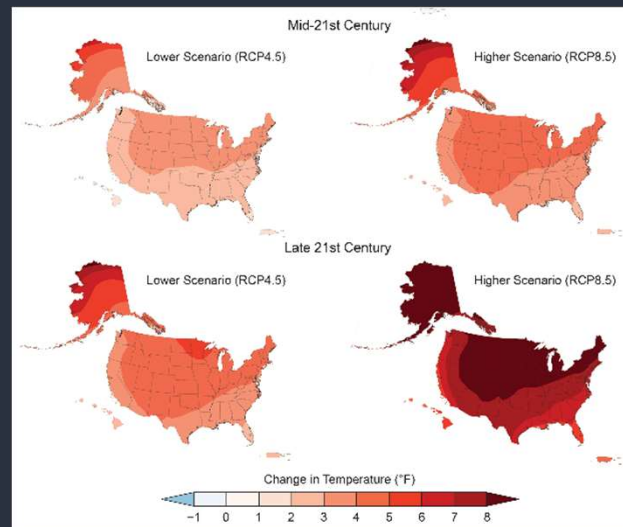
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Warming



Observed change for 1986–2016 relative to 1901–1960

- Across the PNW and Alaska, we've warmed since the early 20th century
- Future warming anticipated to be larger and more rapid
- Warming expected to be largest/fastest in the Arctic



4th National Climate Assessment (2017)



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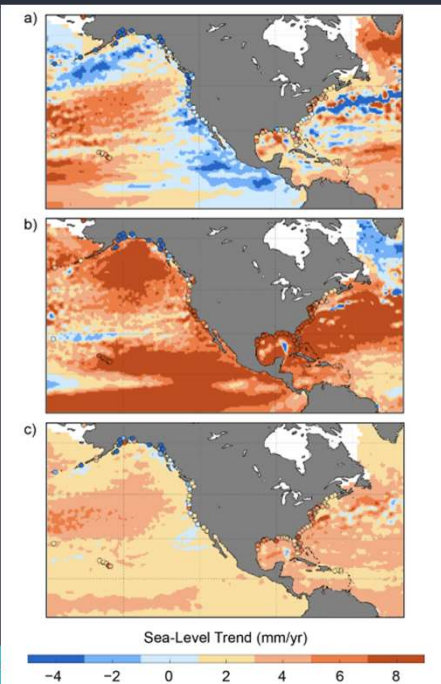
Sea Level Rise

Rate has sped up while rates of isostatic rebound in the Arctic/Sub-Arctic differ at each site

1993-2006

2007-2020

1993-2020



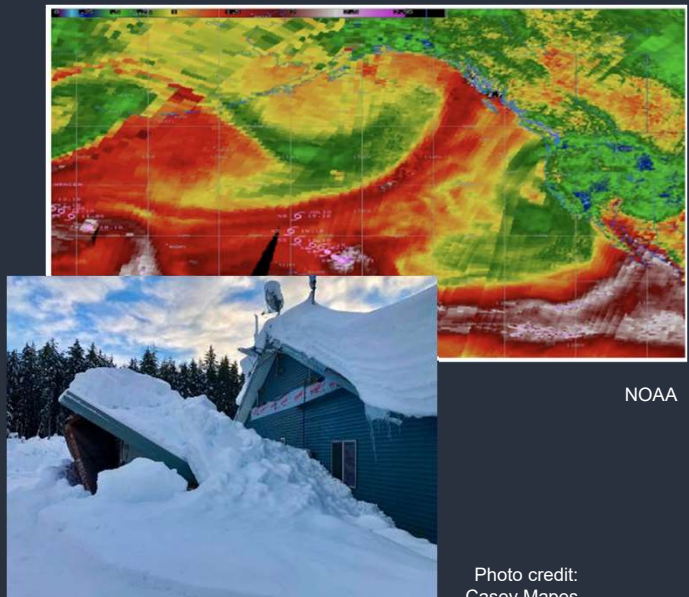
Sweet et al., 2022



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Atmospheric Rivers

May be associated with heavy snowloads (Yakutat this past winter, called in Natl Guard), debris flows, avalanches, landslides, flooding



NOAA

Photo credit: Casey Mapes

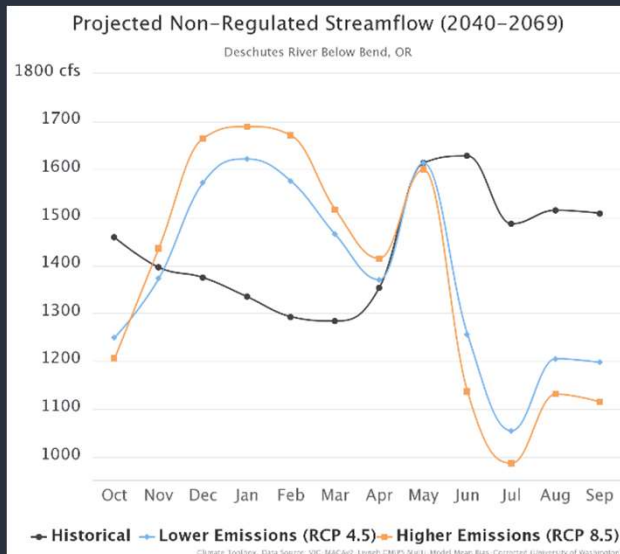


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Hydrological Change in the Pacific Northwest

For snowmelt driven watersheds:

- More precipitation falls as rain in the fall and winter → less snowpack but more streamflow
- The small snowpack leak to less summer streamflow
- The peak streamflow shifts earlier in the water year



<https://climatetoolbox.org/tool/Future-Streamflows>



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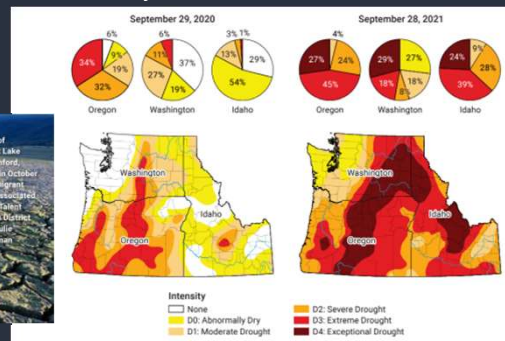
Drought

Impacts of dry periods can be exacerbated by warming

Some areas of the Pacific Northwest are experiencing multi-year drought events



Impacts of sawfly outbreak 2018-2019, Alaska
Photo by Elizabeth Graham/U.S. Forest Service



Bumbaco et al., 2022
2021 Pacific Northwest Water Year Impacts Assessment



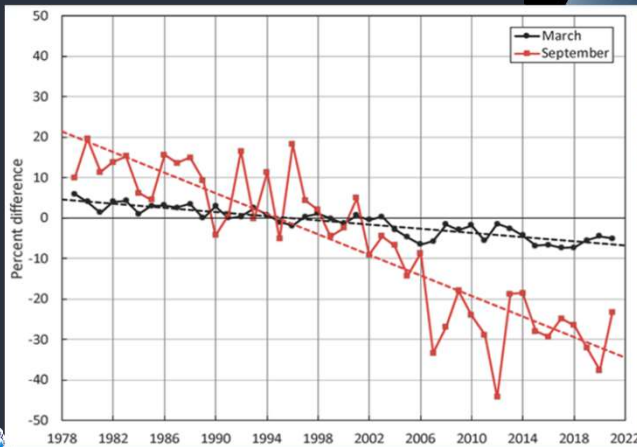
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Dramatic Loss of Arctic Sea Ice

Arctic Sea Ice
Minimum Extent
4.72 Million km²
September 16, 2021
Yellow line: 1981-2010 Avg. Min



Schindler, NASA Scientific Visualization Studio <https://svs.gsfc.nasa.gov/4941>

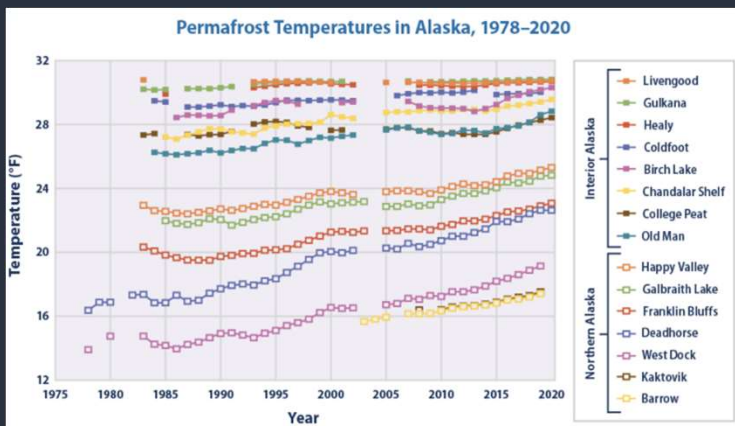


Maier et al. 2021, Arctic Report Card



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Thawing Permafrost



Romanovsky et al., UAF 2021



Fairbanks <https://grist.org/science/alaska-permafrost-thawing-ice-climate-change/>



Usteq – permafrost thaw collapse
USGS <https://dggs.alaska.gov/hazards/permafrost.html>



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Growing threats from wildfire

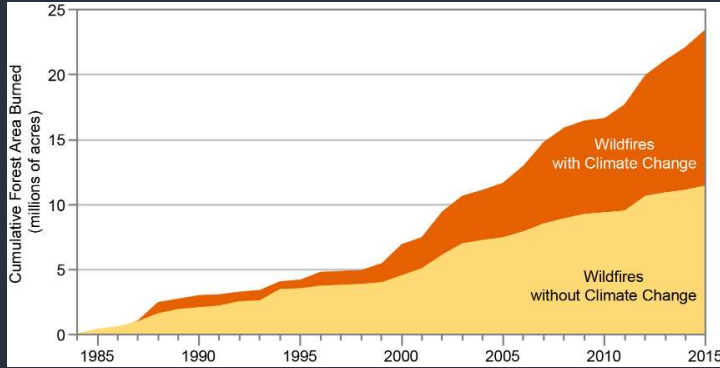


Fig. 25.4: Climate Change Has Increased Wildfire

NCA, 2017; adapted from Abatzoglou and Williams 2016



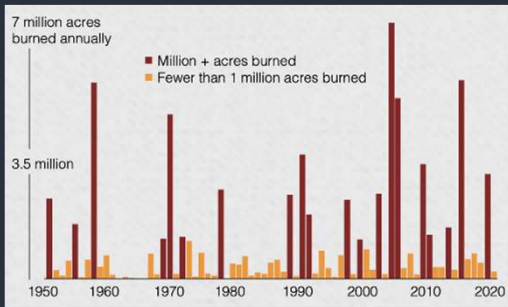
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Fig. 24.8: Wildfires Affect Outdoor Recreation

NCA, 2017; Photo credit: Charles Luce

More fires, more acreage burned



Gabinski and McFarland, 2020



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ALASKA'S CHANGING WILDFIRE ENVIRONMENT

Region Calf Fire, near Chukytak, Alaska
July 2018
Photo by Scott Hines, Alaska Interagency Incident Management Team

Read it online at www.frames.gofac/sce
UNF is an AAEO employer and educational institution and prohibits illegal discrimination against any individual. www.alaska.edu/humanresources/

ALASKA DEPARTMENT OF NATURAL RESOURCES
UNIVERSITY OF ALASKA
Arctic Research Center
ACCAP
UAF
ALASKA

WINTER 2020

Linking climate change to disaster risk*

- Infrastructure impacts
- Human health impacts
- Agricultural and ecological impacts
- Cultural impacts
- Equity consideration

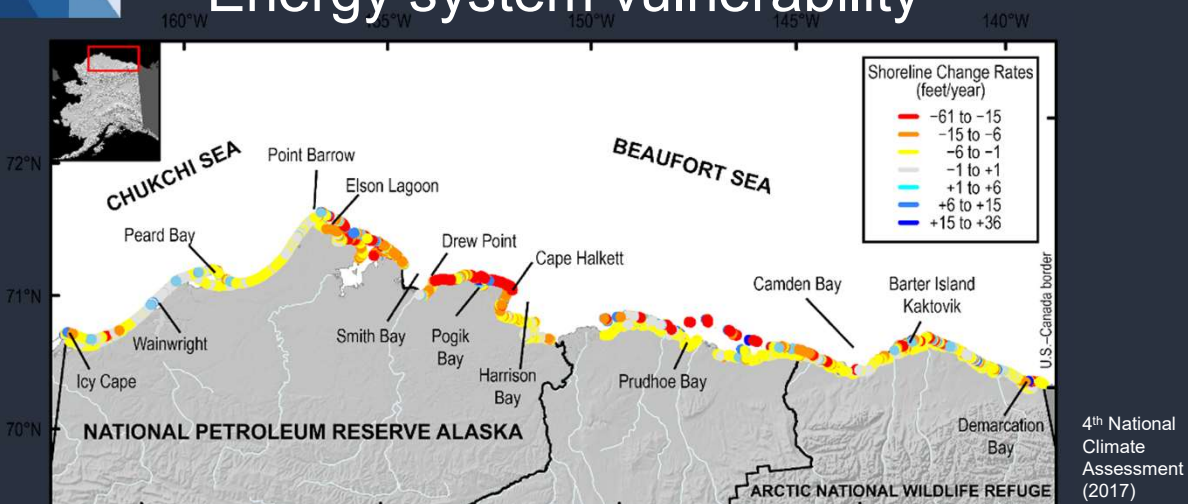
**NOT a comprehensive inventory of risks!*



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Energy system vulnerability



Coastal erosion: reduced sea ice, more wave action, permafrost thaw, higher sea level



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Web of Climate Stressors

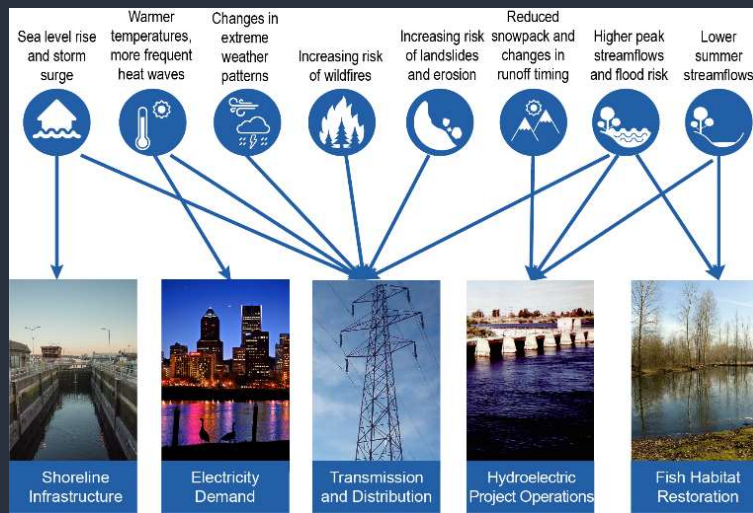


Fig. 24.11: Multiple Climate Stressors Affect Vulnerable Infrastructure

Source: adapted from Raymond 2015.

Photo credits: Emmet Anderson, Justin Miller, photojojo3, U.S. Department of Energy, Rick Swart, Oregon Department of Fish & Wildlife.

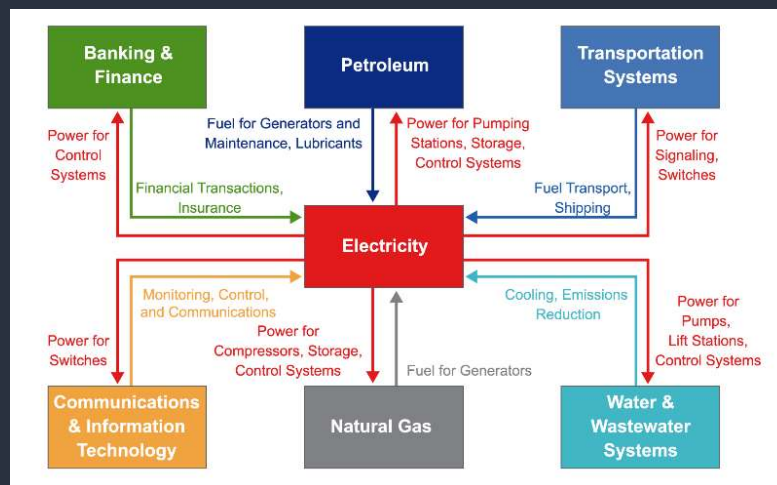
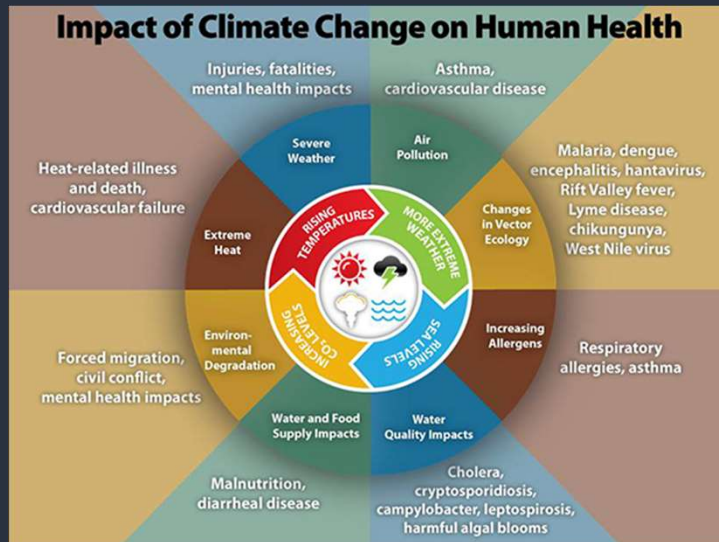


Fig. 4.4: Examples of Critical Infrastructure Interdependencies

Source: adapted from DOE 2017



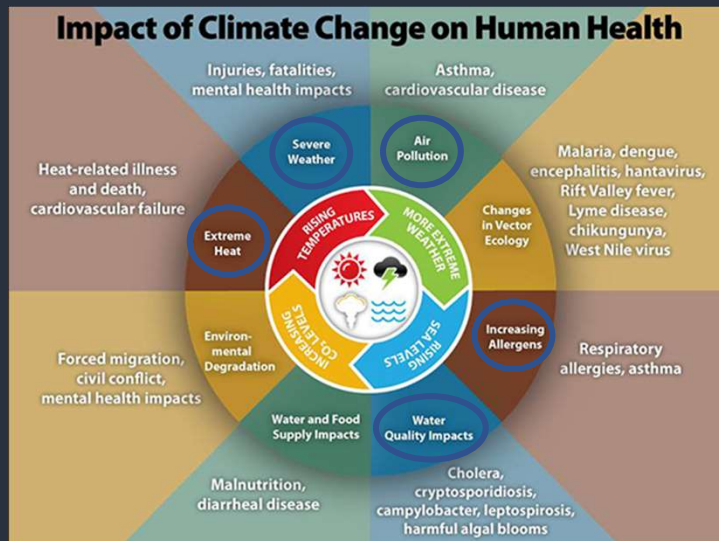
Human health impacts



Source: CDC <https://www.cdc.gov/climateandhealth/effects/default.htm>



Human health impacts



Source: CDC <https://www.cdc.gov/climateandhealth/effects/default.htm>



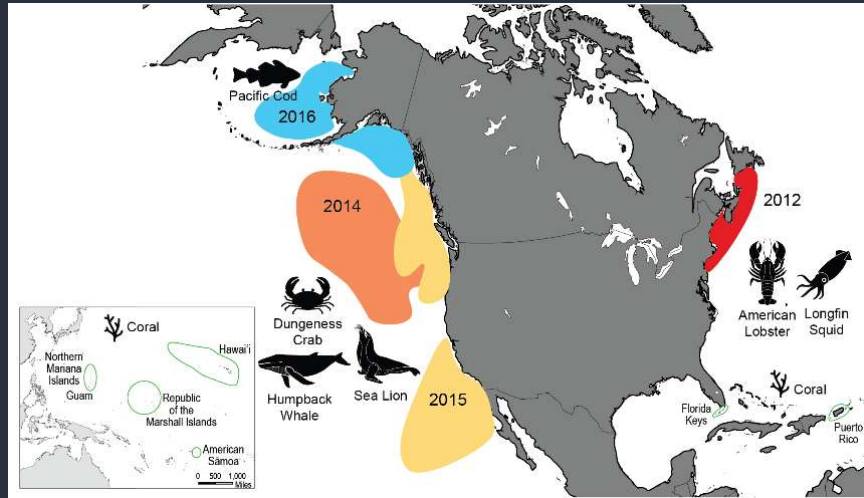


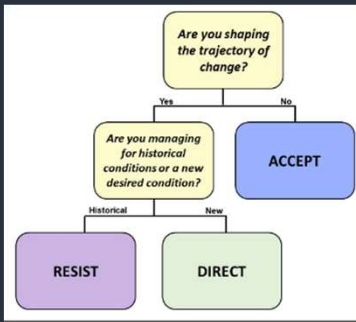
Fig. 9.3: Extreme Events in U.S. Waters Since 2012



Source: Gulf of Maine Research Institute

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Ecological impacts



RAD—A Framework for the 21st-century Natural Resource Manager Natural Resource Report NPS/NRSS/CCRP/INRR—2020/ 2213

<https://www.nps.gov/subjects/climatechange/radframework.htm>

RESIST	ACCEPT	DIRECT
<p>Some changes can be resisted. Managers will work to maintain ecosystem processes, function, and composition without experiencing dramatic, threshold-crossing changes.</p>	<p>Many changes can be accepted, perhaps because they cannot feasibly be resisted or because they are acceptable to—or even desirable by—society. Managers will work to ease the transition.</p>	<p>A few changes can be directed toward a different state, either because resistance is unrealistic or there is an opportunity to direct the change to a more desirable future state. Managers will face a new frontier in overseeing this process.</p>
Kenai Peninsula, Alaska: A Case Study		
<p>Stream banks are restored, the most feasible and deleterious invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Non-native species are monitored for escapement as climate changes.</p>	<p>Glaciers are melting, non-glacial streams are warming, tree line is rising, and wetlands are drying. Many invasives are not managed either due to a lack of feasibility or perceived threat. Society has accepted the changes in fish and wildlife communities, even with higher costs to ecosystem services.</p>	<p>A spruce bark beetle epidemic and human-caused fire have shifted white spruce forests into a novel grassland ecosystem. Non-native trees from neighboring regions are being planted, and the introduction of large grazers is being considered to stabilize the new grasslands and related communities.</p>

<https://www.usgs.gov/media/images/resist-accept-direct-rad-management-framework-and-case-study>



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Cultural Resources

- Landscapes, flora, and fauna have cultural and historical significance
- For indigenous communities, identity and existence are threatened



Fig. 24.9: Pacific Salmon and the Identity and Culture of Northwest Tribes
 Photo credit: Matt Nagle, Puyallup Tribal News

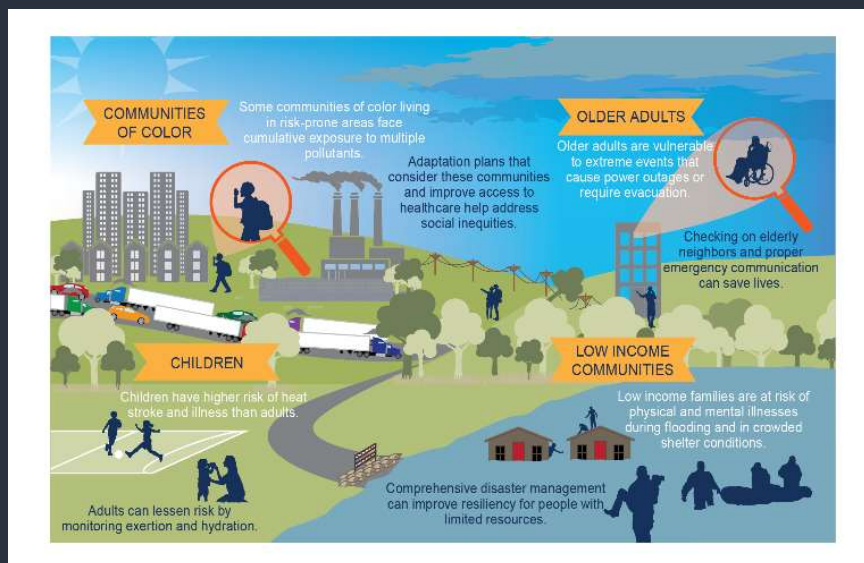


Fig. 14.2: Vulnerable Populations

Source: EPA



What to do with all this “bad news?”

- The risk landscape is changing...
“The future ain’t what it used to be”
- Decisions about mitigation and recovery reduce or amplify risk
- Take a systems approach – land use, infrastructure, resource use, economic development, and equity are interconnected
- Capacity matters – Make it someone’s job!



Thank you!

Feel free to reach out with questions
or comments:

Joe Casola

Joseph.casola@noaa.gov

For images and background
information:

<https://nca2018.globalchange.gov/>



DOC: 14 disaster determinations for Alaska Fisheries issued 1/2022

- Upper Cook Inlet East Side Set Net (2018) and Upper Cook Inlet salmon fisheries (2020)
- Copper River Chinook and sockeye salmon fisheries (2018)
- Prince William Sound salmon fisheries (2020)
- Copper River Chinook, sockeye, and chum salmon fisheries (2020)
- Eastern Bering Sea Tanner crab (2019/2020)
- Pacific cod in the Gulf of Alaska (2020)
- Alaska Norton Sound, Yukon River, Chignik, Kuskokwim River, and Southeast Alaska salmon fisheries (2020)
- Yukon River salmon fishery (2021)

Likely climate drivers: food web, temp-driven mortality

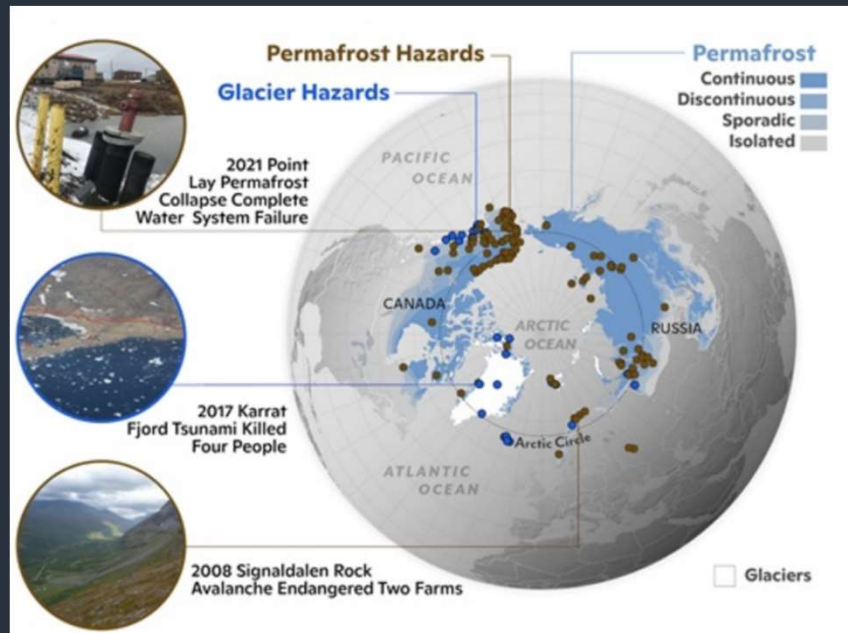


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Secretary of Commerce issues multiple fishery disaster determinations for Alaska
 Determinations address economic impacts from 2018 to 2021
 Focus areas: Fisheries Topics: economic data
 January 21, 2022

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Permafrost and Glacier-related hazards



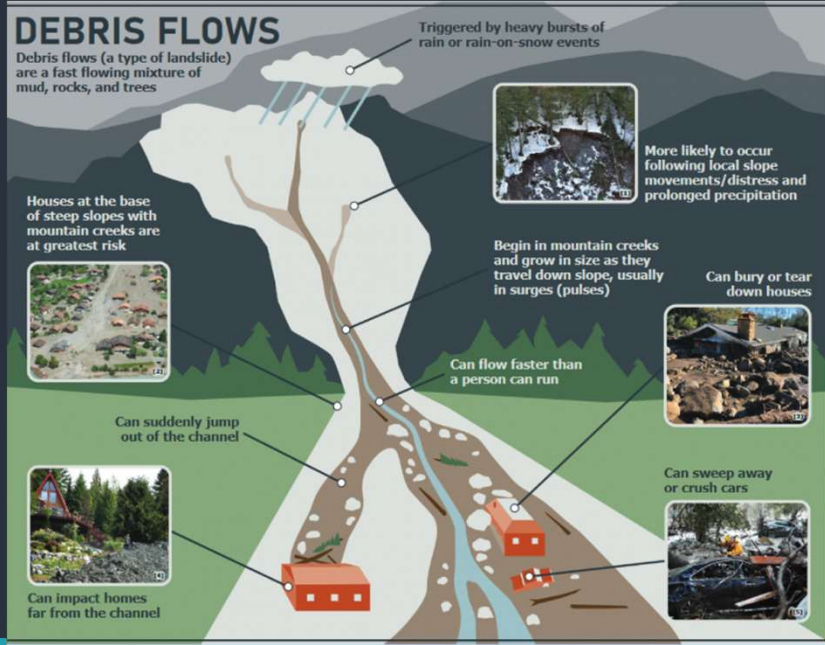
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NOAA Arctic Report Card, 2021

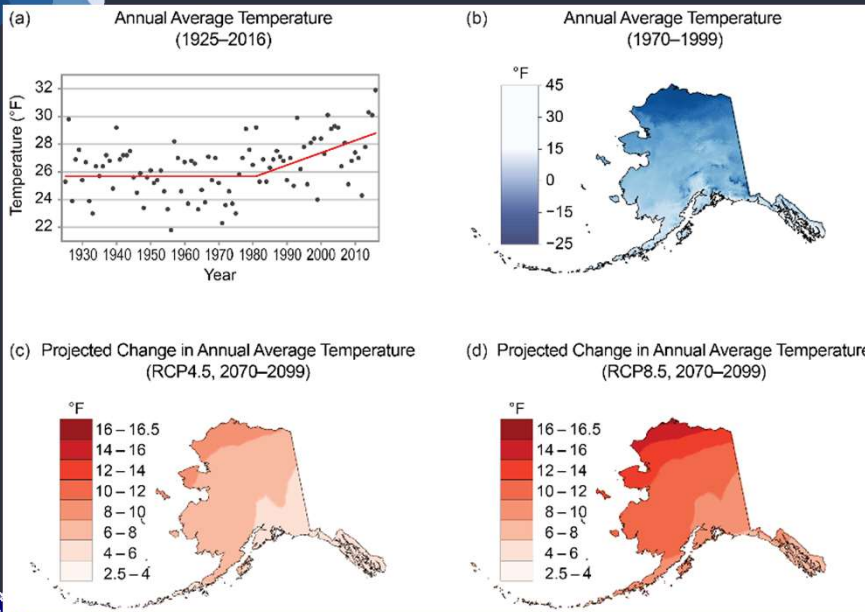
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Haines debris flow disaster of 2020: 2 deaths

Sitka another vulnerable community



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This trend is expected to intensify in the near future under all emissions pathways

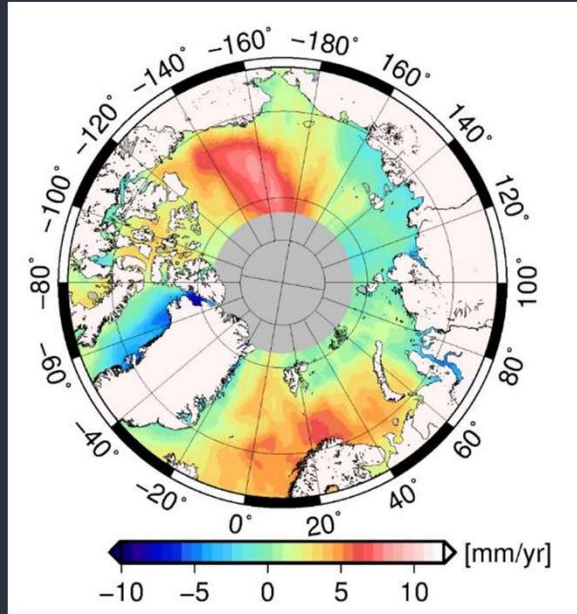


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4th National Climate Assessment (2017)

Sea Level Rise in the Arctic:

Melting Greenland Ice Sheet, Melting Sea Ice, changing ocean thermodynamics



1991 to 2018

Rose et al.
Remote Sensing,
2019

