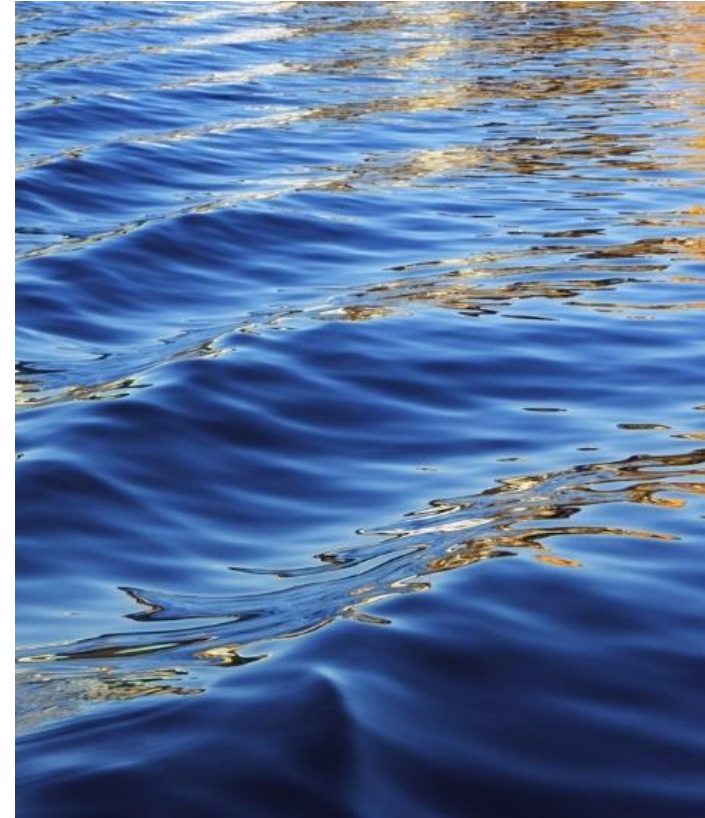




# Storms & Flooding and Melting Ice & Sea Level Rise

Tribal Climate and Health Adaptation Webinar #5



# Since Last Webinar

## Suggested Reading

- National Wildlife Federation: "Facing the Storm: Indian Tribes, Climate-Induced Weather Extremes, and the Future for Indian Country"

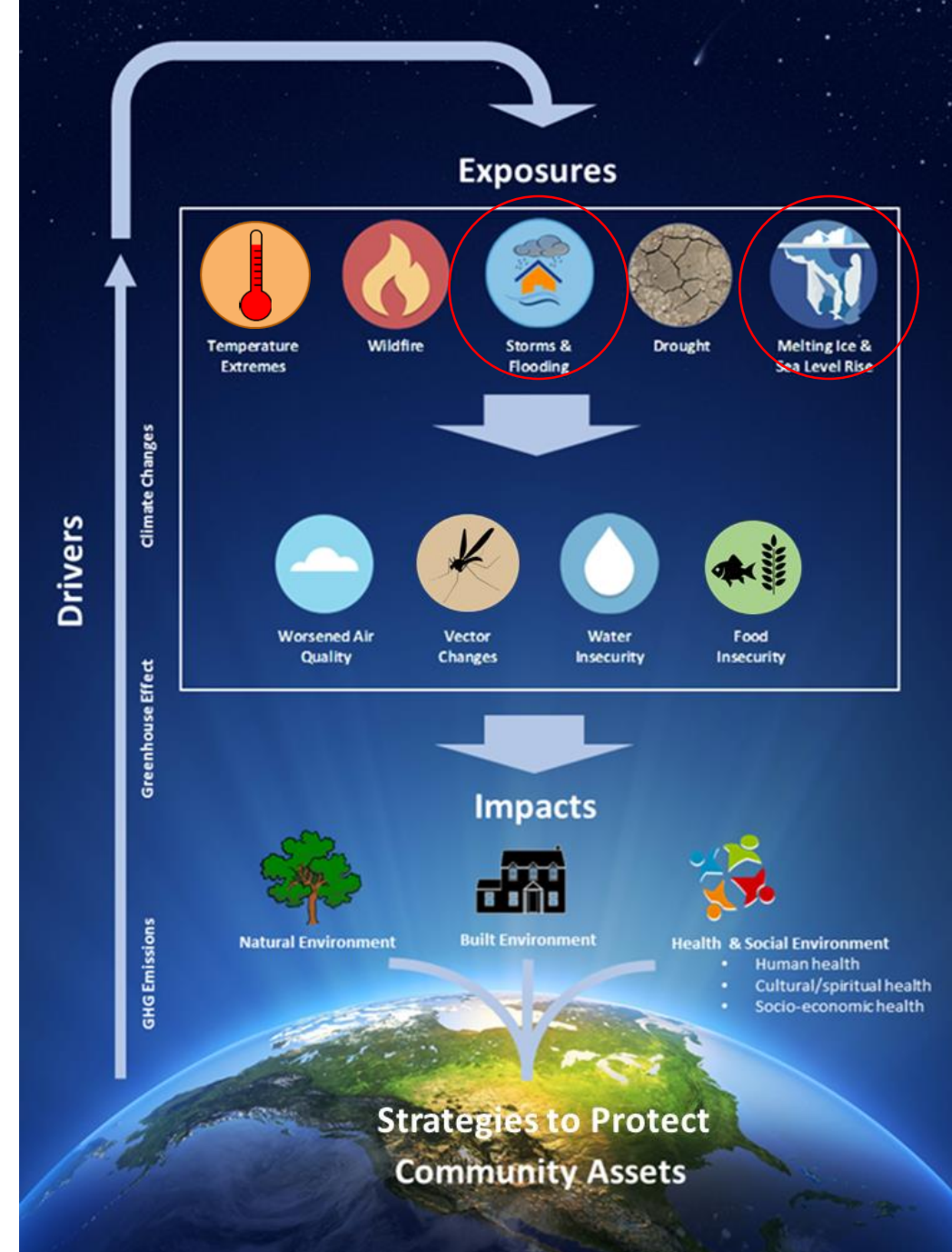


## Chat Discussion:

What did you read about that surprised you?

# TCHP Framework

- Today we cover Storms & Flooding and Melting Ice & Sea Level Rise
  - Secondary exposures
  - Impacts
  - Sample strategies
  - Tribal case studies







# Storms and Flooding





# Storms & Flooding

## Key Climate Exposure Facts

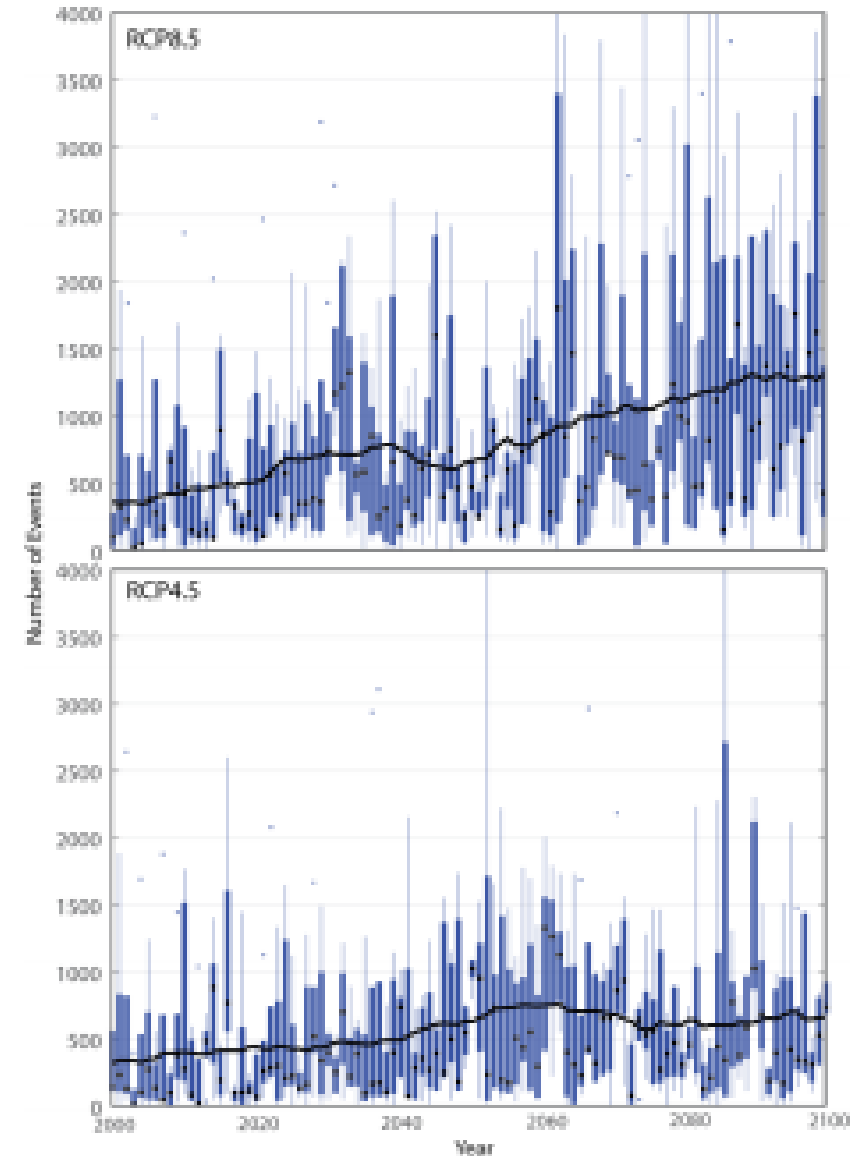
- Severe storms include increased extreme rainfall/snowfall events, an upward trend tropical cyclone activity (including North Atlantic hurricanes, and more variable thunderstorm events (including wind, hail and tornados)
- These storm events trigger flash floods, prolonged flooding along rivers and streams, and coastal flooding
- Exacerbated by sea level rise and earlier snowmelt, along with manmade changes to landscape
- Contribute to landslides, mudslides and erosion
- Number of 100-year floods in the contiguous United States to rise steadily for the remainder of the century
  - Approximately twice as many flood events projected under RCP8.5 compared to RCP4.5 by the end of the century

## Regions Affected

All – varying degrees and types of storms and flooding

Figure 17.1. Number of 100-Year Floods

In each plot, black dots are the median value across the five GCMs throughout the century, each year of the 21<sup>st</sup> century, thick blue bars are the middle 50% of models, whiskers extend to the 5<sup>th</sup> and 95<sup>th</sup> percentile of values, and dots represent outliers. Thick black lines are five-year moving averages for all models.





## Storms & Flooding



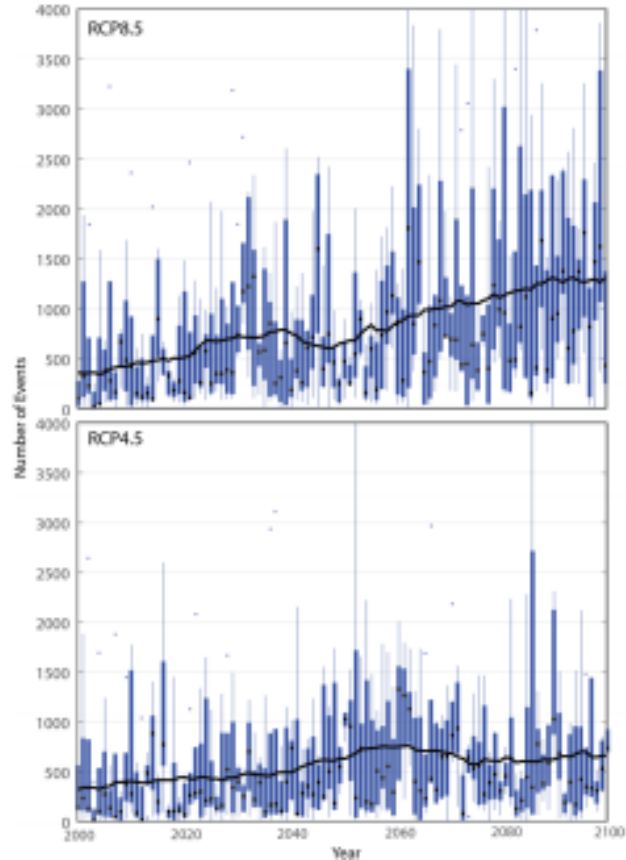
**Group Discussion and Group Polls:**  
What health impacts can you anticipate?



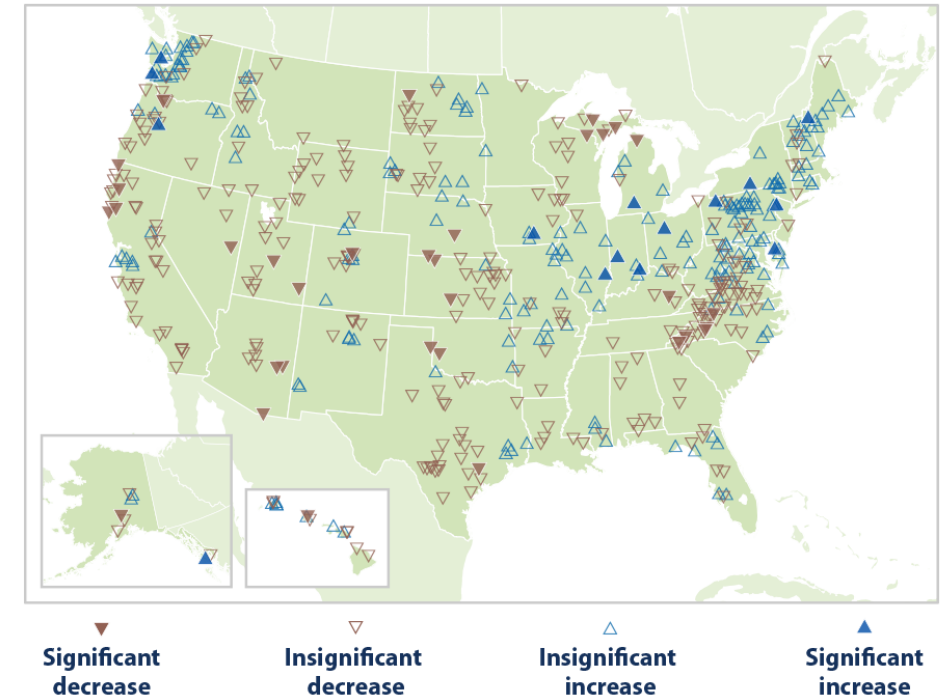
# Storms & Flooding

Figure 17.1. Number of 100-Year Floods

In each plot, black dots are the median value across the five GCMs throughout the contiguous U.S. in each year of the 21<sup>st</sup> century, thick blue bars are the middle 50% of models, whiskers extend to the 95<sup>th</sup> percentile of values, and dots represent outliers. Thick black lines are five-year moving averages across all models.



Change in the Magnitude of River Flooding in the United States, 1965–2015



Data source: Slater, L., and G. Villarini. 2016 update and expansion to data originally published in: Mallakpour, I., G. Villarini. 2015. The changing nature of flooding across the central United States. *Nature Climate Change* 5:250–254.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at [www.epa.gov/climate-indicators](http://www.epa.gov/climate-indicators).

**Group Discussion:**  
What health impacts can you anticipate?





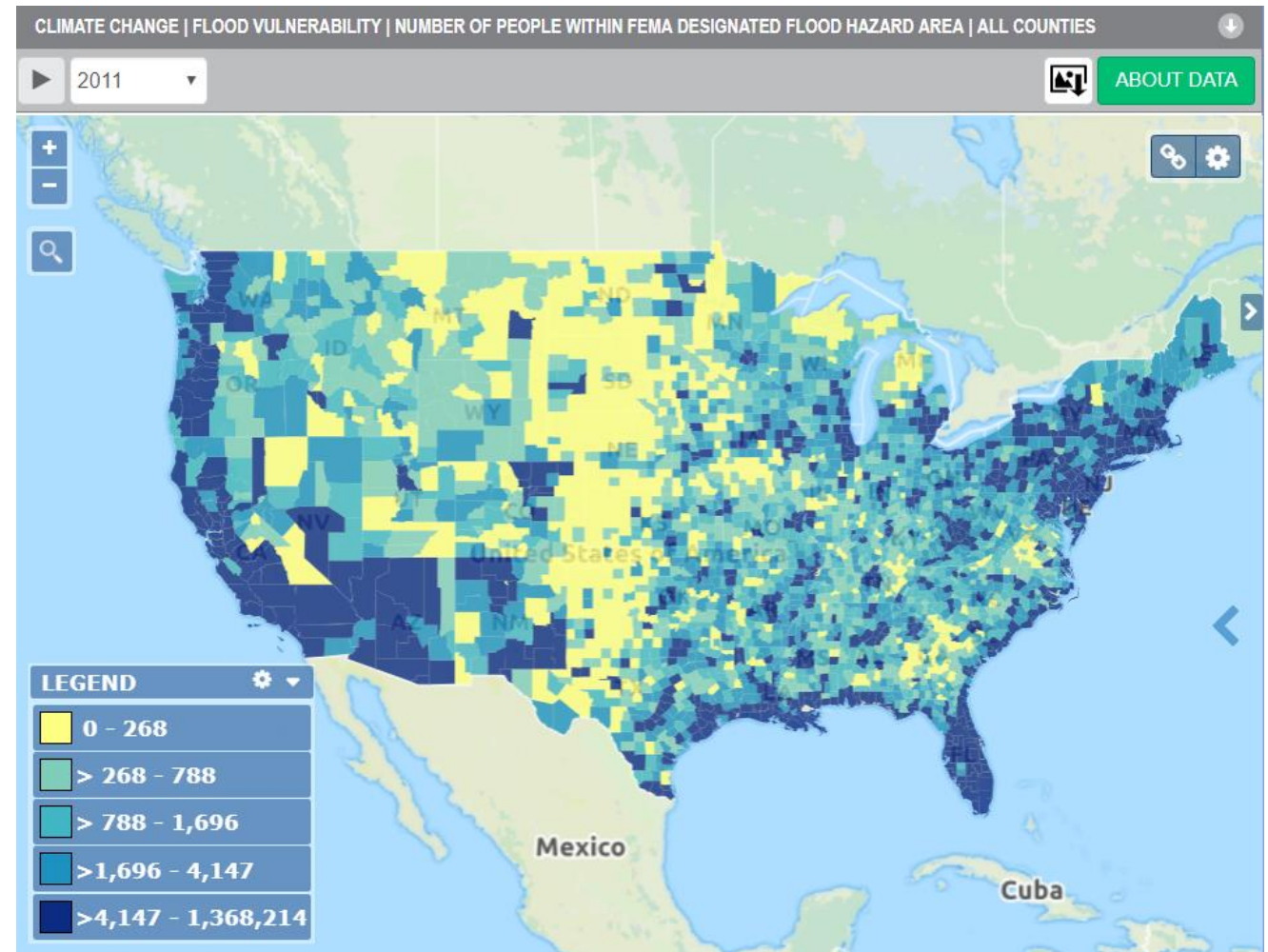
# Storms and Flooding

## Possible Health Impacts

- Storm and flooding-related injury and death
  - Floods are one of the deadliest weather-related hazards in the U.S. – second only to heat
  - In the U.S. inland flooding caused over 4,500 deaths between 1959 and 2005

IMPACTS

People within Flood Hazard Area







# Storms and Flooding

## Possible Health Impacts

- Mental health impacts including post-traumatic stress, depression, anxiety and grief
  - Flood-related mental health impacts are associated with direct and longer-term losses, social impacts, stress, and economic hardship.

## What happens when people experience a disaster or traumatic event?

Shock and denial are typical responses to large-scale natural disasters, especially shortly after the event. Both shock and denial are normal protective reactions.

Once the initial shock subsides, reactions vary from one person to another. The following are common responses to a traumatic event:

- **Feelings become intense and sometimes are unpredictable.** You may become more irritable than usual, and your mood may change back and forth dramatically. You might be especially anxious or nervous, or even become depressed.
- **Thoughts and behavior patterns are affected.** You might have repeated and vivid memories of evacuating or seeing the fire approach. These flashbacks may occur for no apparent reason and may lead to physical reactions such as rapid heartbeat or sweating. You may find it difficult to concentrate or make decisions, or become more easily confused. Sleep and eating patterns also may be disrupted.
- **Recurring emotional reactions are common.** Reminders or "triggers" such as smoke, ash, sirens or fire trucks can create anxiety.
- **Interpersonal relationships can become strained, particularly if you are living in temporary housing.** You may experience arguments with family or friends. On the other hand, you might become withdrawn and isolated and avoid your usual activities.
- **Physical symptoms may accompany the extreme stress.** For example, headaches, nausea and chest pain may result and may require medical attention. Pre-existing medical conditions may worsen due to the stress.

It is important to realize that there is no one 'standard' pattern of reaction to the extreme stress of traumatic experiences.



# Storms and Flooding

## Possible Health Impacts

- Damage to infrastructure limits access to health services, can result in illness and carbon monoxide poisoning
  - Power outages & de-energization
  - Road closures
  - Damaged health and emergency facilities
  - Emergencies can overwhelm health and emergency services
  - Can also lead to school and business closures and economic damages

IMPACTS

INDUSTRY DX

Kevin Joy

September 11, 2017 1:00 PM

## Ripple Effect: How Hurricanes and Other Disasters Affect Hospital Care

*Natural disasters can overwhelm busy hospitals for days after storms dissipate. The reason: a wave of medical needs — beyond injuries — from patients without resources.*





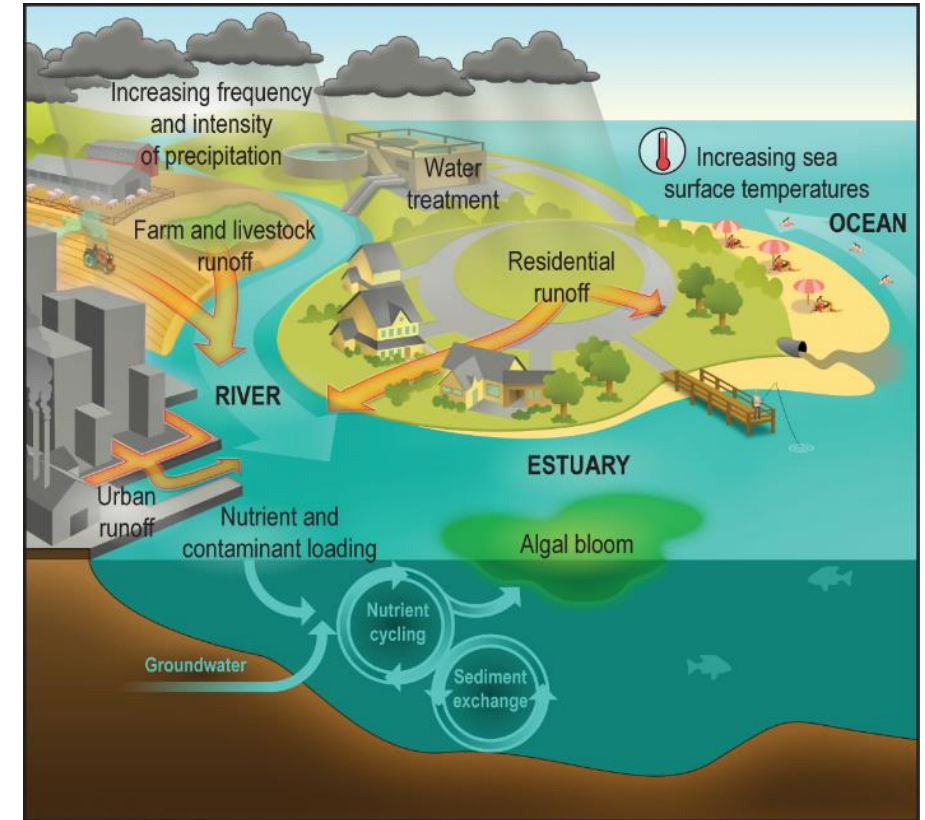
# Storms and Flooding

## Related Exposures

- Triggers the following secondary exposures:



- Indoor Mold
- Mosquitos
- Water contamination and supply disruption
- Food contamination and supply disruption



## Chat Discussion:

What health impacts can you anticipate?





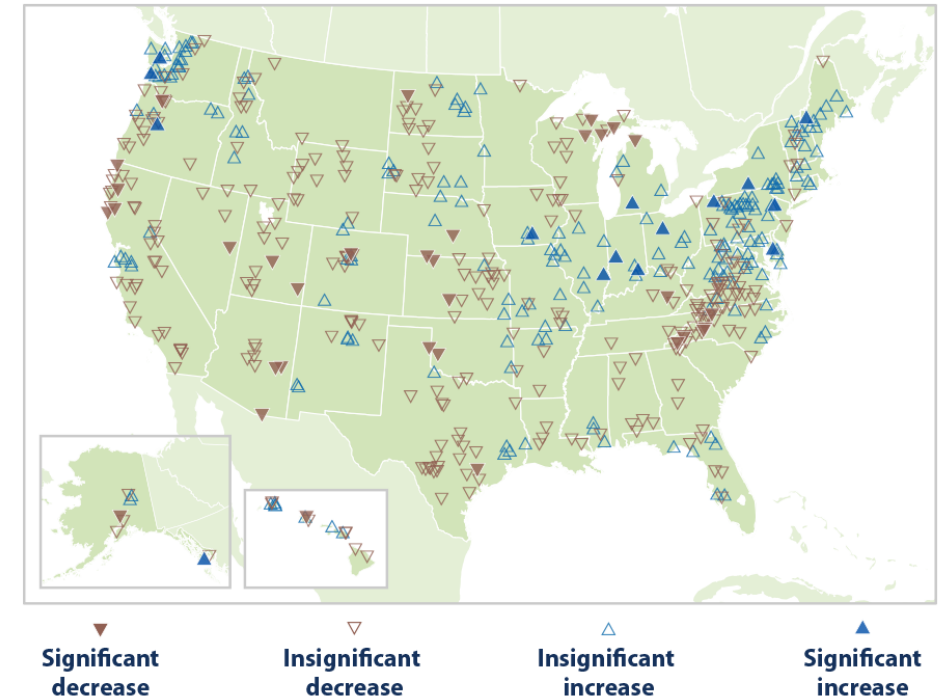
# Storms and Flooding

## Possible Health Impacts

- Illness associated with mold exposure



Change in the Magnitude of River Flooding in the United States, 1965–2015



Data source: Slater, L., and G. Villarini. 2016 update and expansion to data originally published in: Mallakpour, I., G. Villarini. 2015. The changing nature of flooding across the central United States. *Nature Climate Change* 5:250–254.

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# IMPACTS

## Storms and Flooding

### Possible Health Impacts

- Infections and illness from contaminated water and marine food
- Drinking water and food supply interruption
- Lack of nutritional and medicinal abundance



David Gibbons, left, and Shane Mesteth ride down a muddy road to the highway to gather food, water and medical supplies for residents on the Pine Ridge Indian Reservation in South Dakota. Kristina Barker for The New York Times

### *'A State of Emergency': Native Americans Stranded for Days by Flooding*

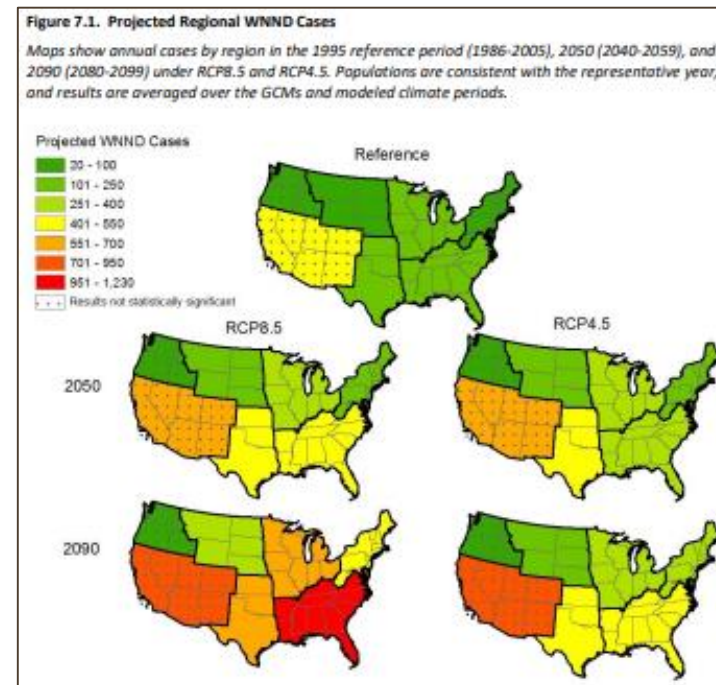
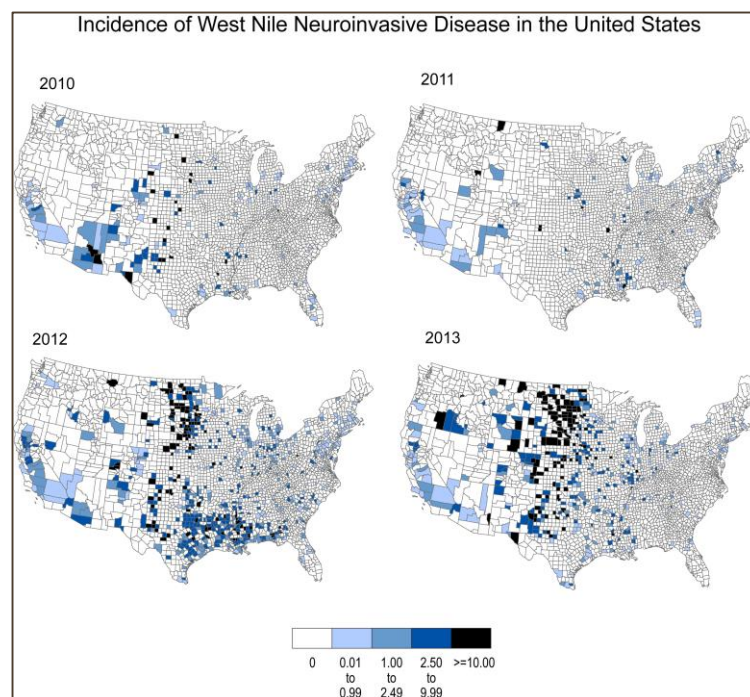
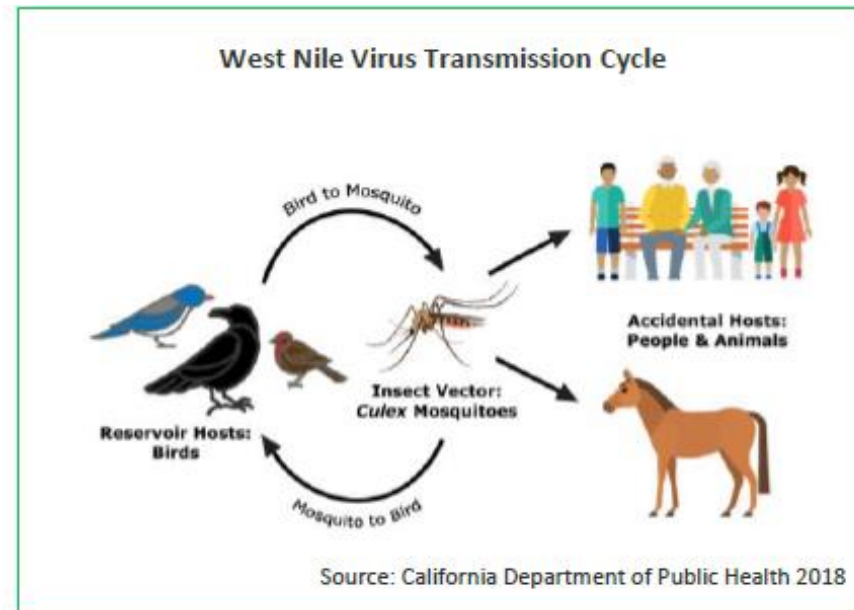
On the Pine Ridge Indian Reservation in South Dakota, extreme weather and bad roads have left some residents stranded for nearly two weeks with limited food and water.



# Storms and Flooding

## Possible Health Impacts

- Vector borne disease (e.g. **West-Nile, Zika, Dengue**)





# Storms and Flooding

## Vulnerable Populations

- Children and elders
- Residents living in older homes
- Neighborhoods lacking green space
- People with physical disabilities
- People without health insurance
- People susceptible to health impacts from poor air quality
- People with mental, behavioral, and cognitive disorders
- Electricity-dependent populations
- Outdoor workers
- Transit-dependent populations
- Households in poverty

## Sample of Population Sensitivity and Adaptive Capacity Factors

- 100 and 500 year flood area
- Hydrogeological conditions
- % area covered by impervious surface
- Population or critical structures within floodplain
- Hospitals per 100,000
- Economic hardship or social vulnerability index
- Community cohesion





# Storms and Flooding

## Possible Impacts to Social, Economic and Cultural Health

- Displacement, destruction of historical or cultural sites/assets
- Lost school days and business revenues
- Economic damage (e.g. response and recovery costs; fishing losses)



## Chat Discussion:

How might cultural wellbeing and traditional ways of life be disrupted by storms and flooding?





# Storms and Flooding

## Natural Environment Impacts

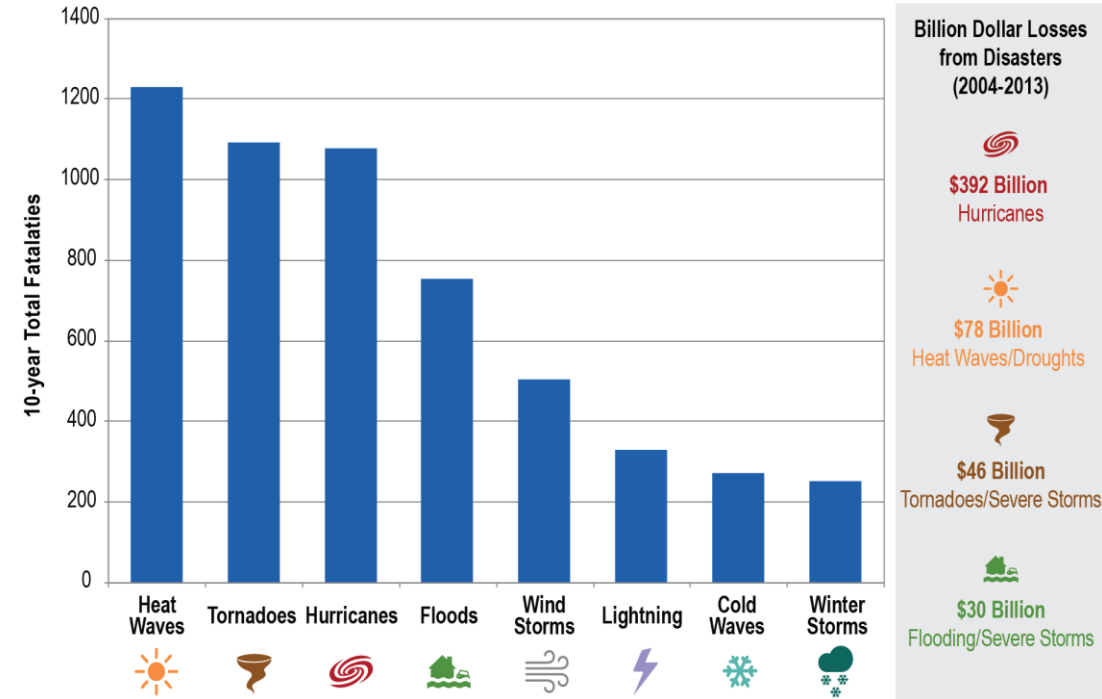
- Storm and flooding related disruptions, declines and stresses to habitats, waterways, and important or sensitive plant and wildlife species (e.g. loss of vegetation, erosion, runoff, fish mortality)

## Built Environment Impacts

- Damage to homes and businesses
- Disruption to public services and infrastructure (e.g. roads, water treatment)

IMPACTS

Estimated Deaths and Billion Dollar Losses from Extreme Events in the U.S., 2004–2013



## Chat Discussion:

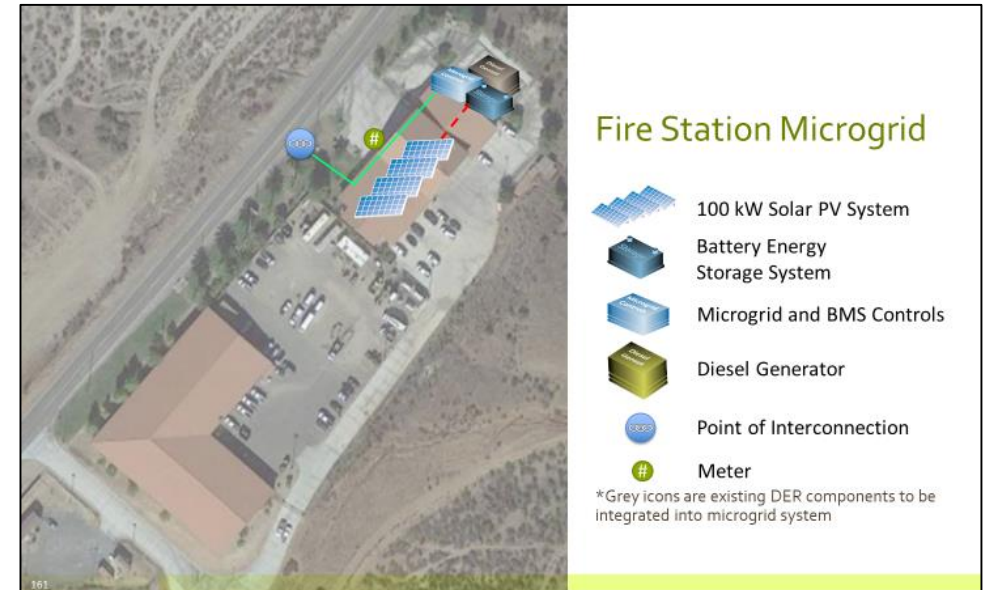
What adaptation strategies may be able to reduce negative impacts to your community?



# Storms and Flooding

## Sample Strategies to Address Impacts

- Develop policies and plans to preserve wetlands and establish vegetated buffers along rivers and streams to reduce flooding, runoff and erosion.
- Restrict development in high-risk or post-disaster areas to reduce losses.
- Develop preventative initiatives before next disaster to build human resilience skills
- Connect community members to financial resources for disaster insurance
- Build alternative power supplies e.g. building or community-scale microgrids incorporating renewables to avoid power outages for critical facilities during storms and flood
- Seek assistance, resources, grants and loans from federal agencies for disaster planning, emergency management, distressed communities





# Storms and Flooding

## Tribal Case Study

### Flash Floods on The Drought-Impacted Hopi Reservation

- Severe drought conditions prior to 2010 heavy rainfall event and rockslides
- \$930,000 in costs to repair roads, telephone lines, and water and sewer systems
- Gravesites damaged





# Storms and Flooding

## Trainee Examples





# Melting Ice & Sea Level Rise





# Melting Ice & Sea Level Rise

## Key Climate Exposure Facts

- Rising temperatures are increasing ocean water mass (melting ice) and volume (thermal expansion)
- Global mean sea level (GMSL) has risen by about 7–8 inches (about 16–21 cm) since 1900, with about 3 of those inches (about 7 cm) occurring since 1993 (CSSR)

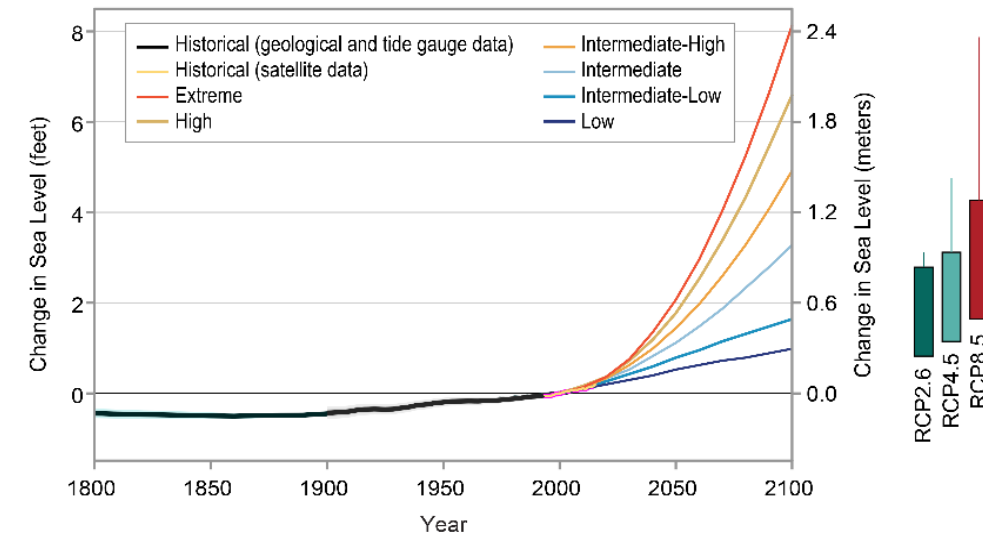
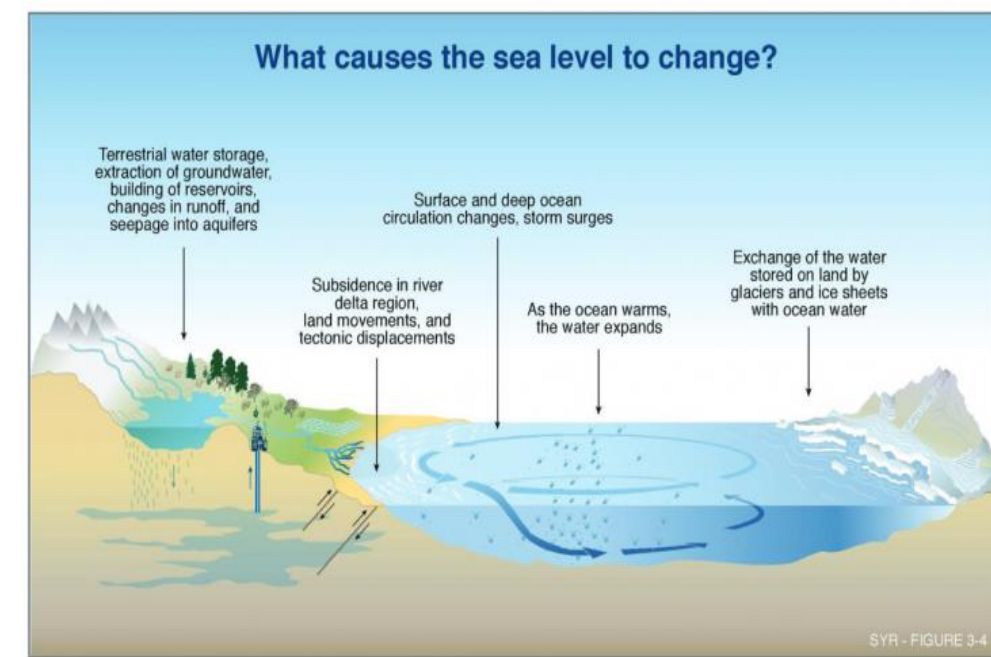
## Related Exposures

- Contributes to storm surges and coastal flooding
- Triggers the following secondary exposures:



## Regions Affected

Alaska, Coastal



**Group Discussion:**  
What health impacts can you anticipate?



# Melting Ice and Sea-level Rise

## Possible Human Health Impacts

- Storm surges increase “Storm and Flooding” health impacts. In addition:
- Melting, thinning and thawing ice-related injuries (e.g. hunting and fishing)
- Lack of nutritional abundance due to loss of safe hunting, fishing or herding practices
- Mental health impacts including post-traumatic stress, depression, anxiety and grief
- Prehistoric diseases unearthed

## Sample of Population Sensitivity and Adaptive Capacity Factors

- Proximity to coast, ice and permafrost



Curtis Nayopuk





# Melting Ice and Sea-level Rise

## Possible Impacts to Social, Economic and Cultural Health

- Displacement, destruction of historical or cultural sites/assets
- Lost school days and business revenues
- Economic damage (e.g. response and recovery costs; fishing/hunting losses)



## Chat Discussion:

How might cultural wellbeing and traditional ways of life be disrupted by melting ice and sea-level rise?





# Melting Ice and Sea-level Rise

## Natural Environment Impacts

- Disruptions, declines and stresses to habitats, waterways, and important or sensitive plant and wildlife species (e.g. habitat fragmentation, saltwater intrusion)

## Built Environment Impacts

- Damage to homes and businesses
- Disruption to public services and infrastructure (e.g. power outages)
- Disruption to agricultural operations

Photographs of McCall Glacier, Alaska, 1958 and 2003



Sources:  
- Post, A. 1958. McCall Glacier. Glacier photograph collection. Boulder, Colorado: National Snow and Ice Data Center/World Data Center for Glaciology. <http://nsidc.org/data/g00472.html>.  
- Nolan, M. 2003. McCall Glacier. Glacier photograph collection. Boulder, Colorado: National Snow and Ice Data Center/World Data Center for Glaciology. <http://nsidc.org/data/g00472.html>.

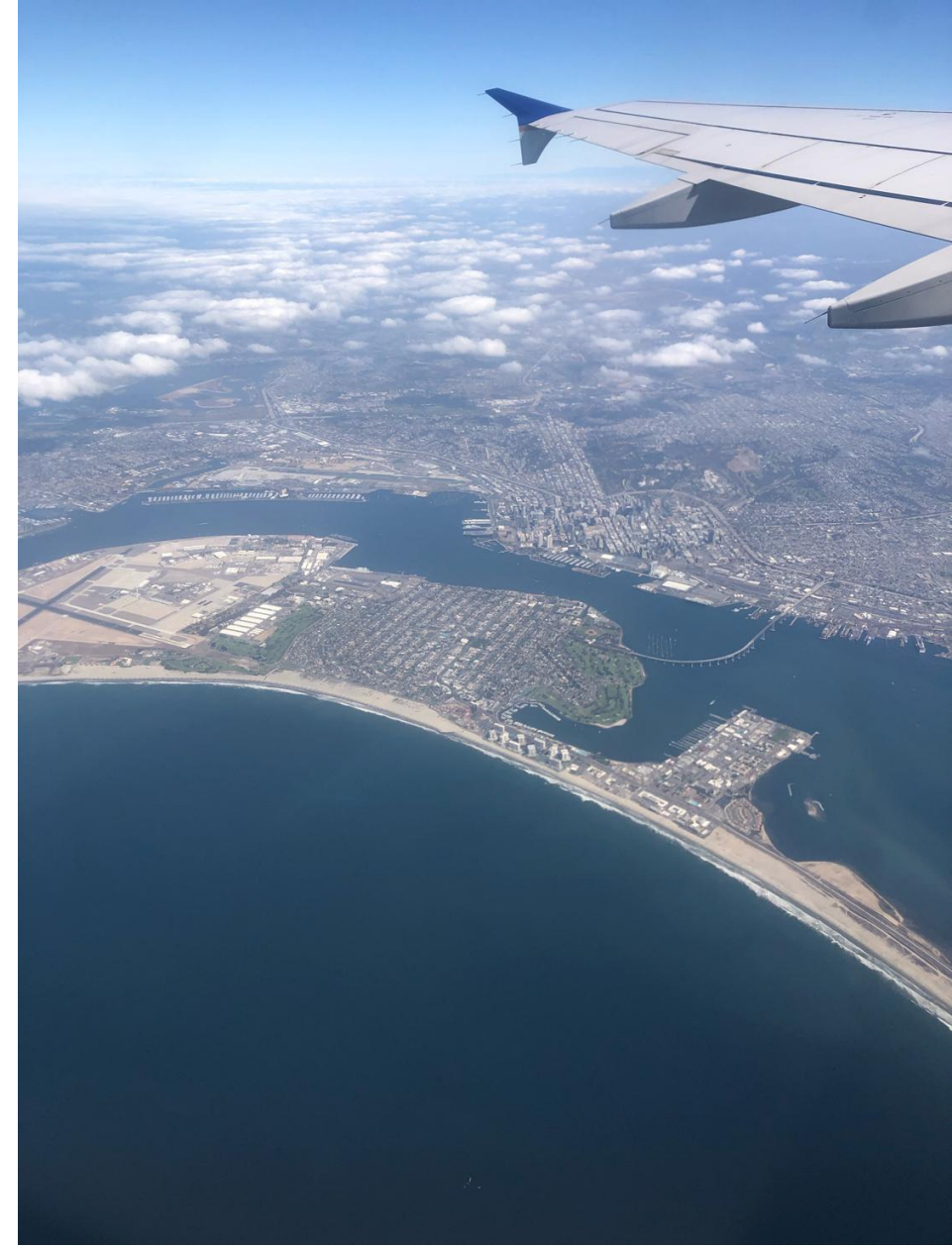
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## Melting Ice and Sea-level Rise

### Sample Strategies to Address Impacts

- Update Hazard Mitigation Plan to include melting ice and sea level rise projections
- Relocate critical facilities and roads that have experienced repeated exposure to melting ice and sea level rise
- Develop plans for phased relocation, if necessary, including opportunities to retain community and cultural cohesion
- Build flood and saltwater intrusion barriers to protect assets (e.g. fortify seawalls, diking, aquifer recharge)
- Implement advanced surveillance equipment for locational ice changes hazards (for hunters)
- Establish a regional network of environmental observers (e.g. LEO Network)





# Melting Ice and Sea-level Rise

## Tribal Case Study

Thinning Ice at Shishmaref, Alaska


- Since 2001, an average of 23 feet of shoreline is being lost per year because of storms.
- A few of the village's 60 or so buildings have already been abandoned given their proximity to the edge of the town's eroding shoreline
- Eighty-six percent of Alaska Native Villages are threatened by thawing permafrost, erosion and flooding. Thirty-one villages face imminent threats and at least 12 have decided to relocate or to explore relocation options.

Relocation of Biloxi-Chitimacha-Choctaw tribe (LA)

- Tribe lost 98% of its land on the Isle de Jean Charles since the 1950s
- Hurricanes have destroyed houses and caused families to leave





A scenic landscape featuring a range of mountains in the background under a bright blue sky filled with fluffy white clouds. The foreground shows some greenery and a clear horizon line.

**Individual Reflection:** Please take a few minutes to complete Section 2 of “Your Work, Your Community” Form



# Wrapping Up

Thank you for being part of our training community!

**Suggested reading** (complete before next webinar)

- Oregon Climate Change Research Institute: [“Tribal Climate Chang Guidebook”](#) Pages 36-38

Next webinar:

**October 15, 2019 (9AM PST / Noon EST)**

## **Vulnerability Assessments Part 1 (Module 3)**

Questions?

# Changing Exposures and Impacts – Key Resources

## Guidance

- USGCRP – [Impacts of Climate Change on Human Health in the United States](#)
- USGCRP - [Fourth National Climate Assessment](#)
  - [Climate Science Special Report](#)
  - [Human Health Chapter](#)
  - [Tribes And Indigenous Peoples Chapter](#)
  - [Water Chapter](#)
- USGCRP - [Third National Climate Assessment](#)
  - [Indigenous Peoples, Lands, and Resources](#)
  - [Human Health](#)
- EPA [Climate Change Indicators in the United States](#)
- EPA - [Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment](#)
- CDC - Assessing Health Vulnerability to Climate Change A Guide for Health Departments
- [IPCC – Chapter 11: Human Health: Impacts, Adaptation, and Co-benefits](#)
- National Wildlife Federation: [Facing the Storm: Indian Tribes, Climate-Induced Weather Extremes, and the Future for Indian Country](#)
- APHA [How Climate Change Affects Your Health](#)
- Tribal Public and Environmental Health Think Tank – [Priorities in Tribal Public Health](#)

- National Indian Health Board – [Climate Ready Tribes](#)
- Drought.gov – [Current Conditions](#)
- FEMA- [Aquifer Storage and Recovery Fact Sheet](#)

## Tools and Templates

- TCHP - [Exposures, Impacts, Strategies Inventory \(EISI\) tool – Beta Version](#)
- TCHP – [Blog: “Data Sources to Assess Tribal Climate and Health Data”](#)
- TCHP – [Resources Clearinghouse](#)

## Examples

- Reuters - [Biloxi-Chitimacha-Choctaw](#)
- UNC - [Thinning Ice at Shishmaref, Alaska](#)
- National Wildlife Federation - [White Mountain Apache Tribe \(Arizona\) and the Rodeo Chediski Fire](#)
- US Climate Resilience Toolkit – [Navajo Nation: Hotter, Drier Climate Puts Sand Dunes on the Move](#)
- U.S. Climate Resilience Toolkit - [Mescalero Apache Tribe Adapts to Warmer and Drier Climate](#)
- National Wildlife Federation – [Flash Flood on The Drought-](#)

[Impacted Hopi Reservation; Thinning Ice Threatens Alaska Native Village of Shishmaref, Alaska](#)

- Climate Adaptation Knowledge Exchange – [The Igliniit Inuit Sea Ice Use and Occupancy Project](#)
- U.S. Climate Resilience Toolkit - [Inupiat Work to Preserve Food and Traditions on Alaska's North Slope](#)
- NIHB - [Climate Ready Tribes](#)
- High Country News – [Northern California tribes face down massive wildfires](#)