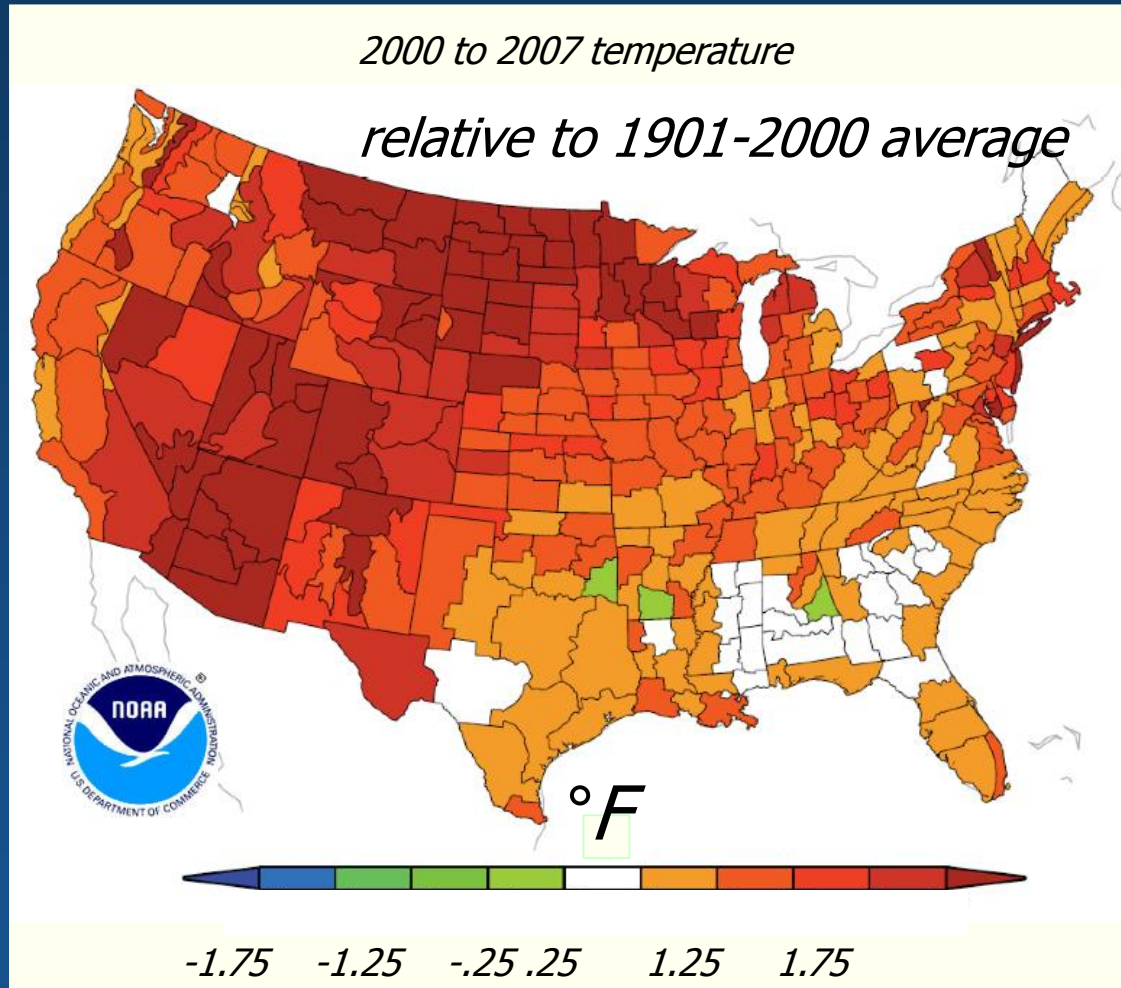


Climate change impacts on water resources of American Indians and Alaskan Natives in the U.S.

K. Cozzetto; Karletta Chief; K. Dittmer; M. Brubaker; R. Gough; K. Souza; F. Ettawageshik; S. Wotkyns; S. Opitz-Stapleton; S. Duren; and P. Chavan

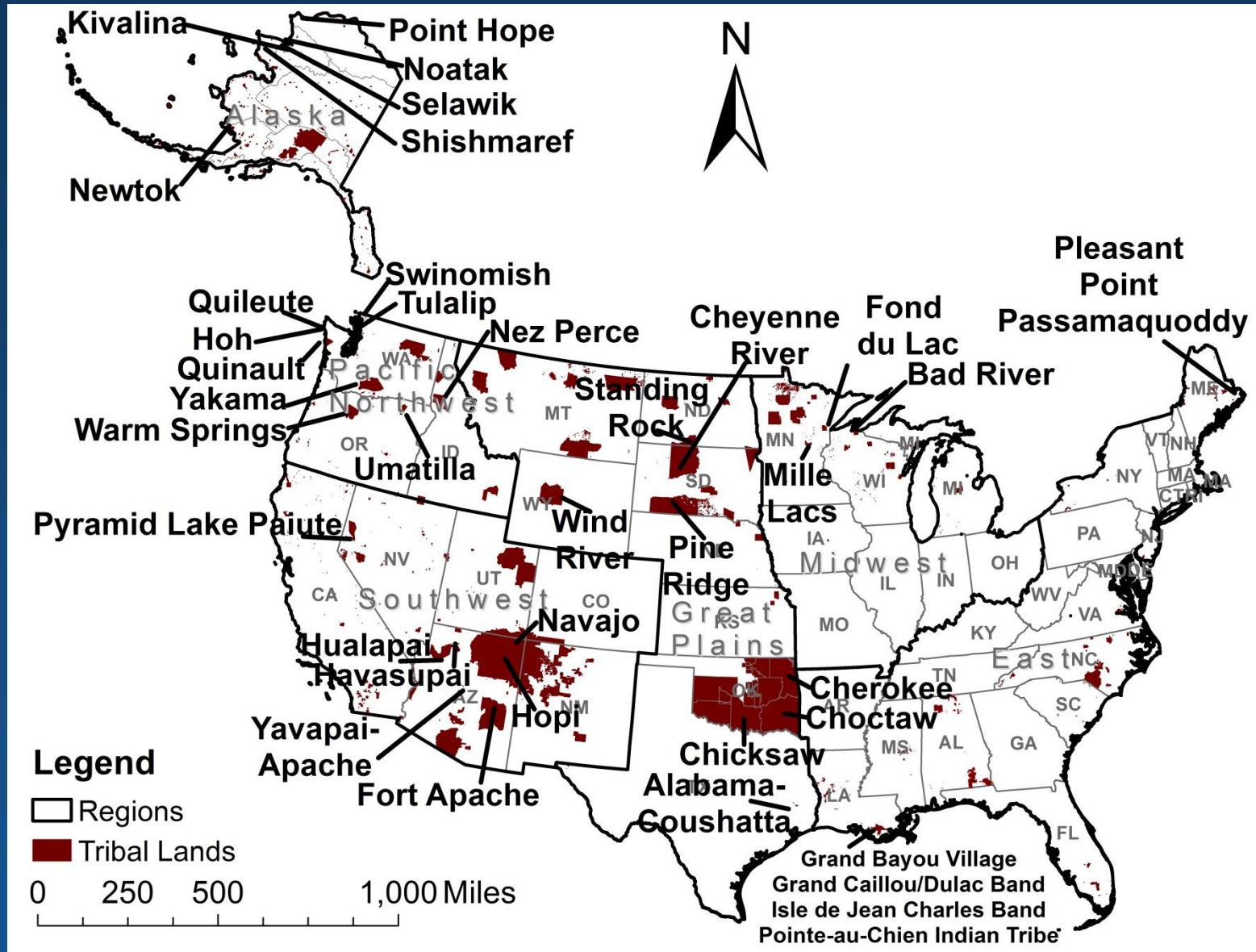
Rapid Warming Trend

- Parts of the West have already warmed more than 2°F compared to average 20th century temperatures

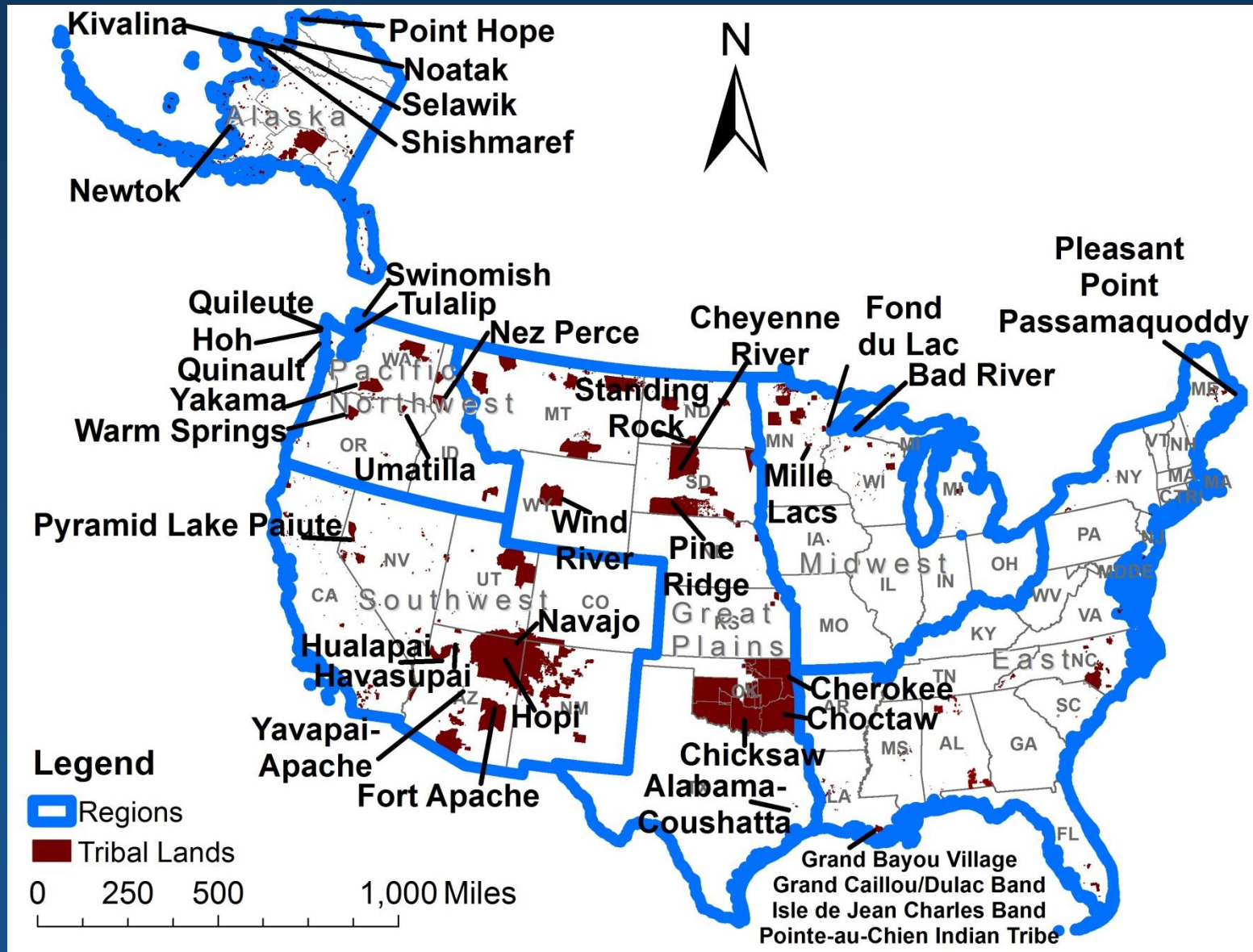


map from M. Hoerling, NOAA; Slide courtesy of J. Overpeck

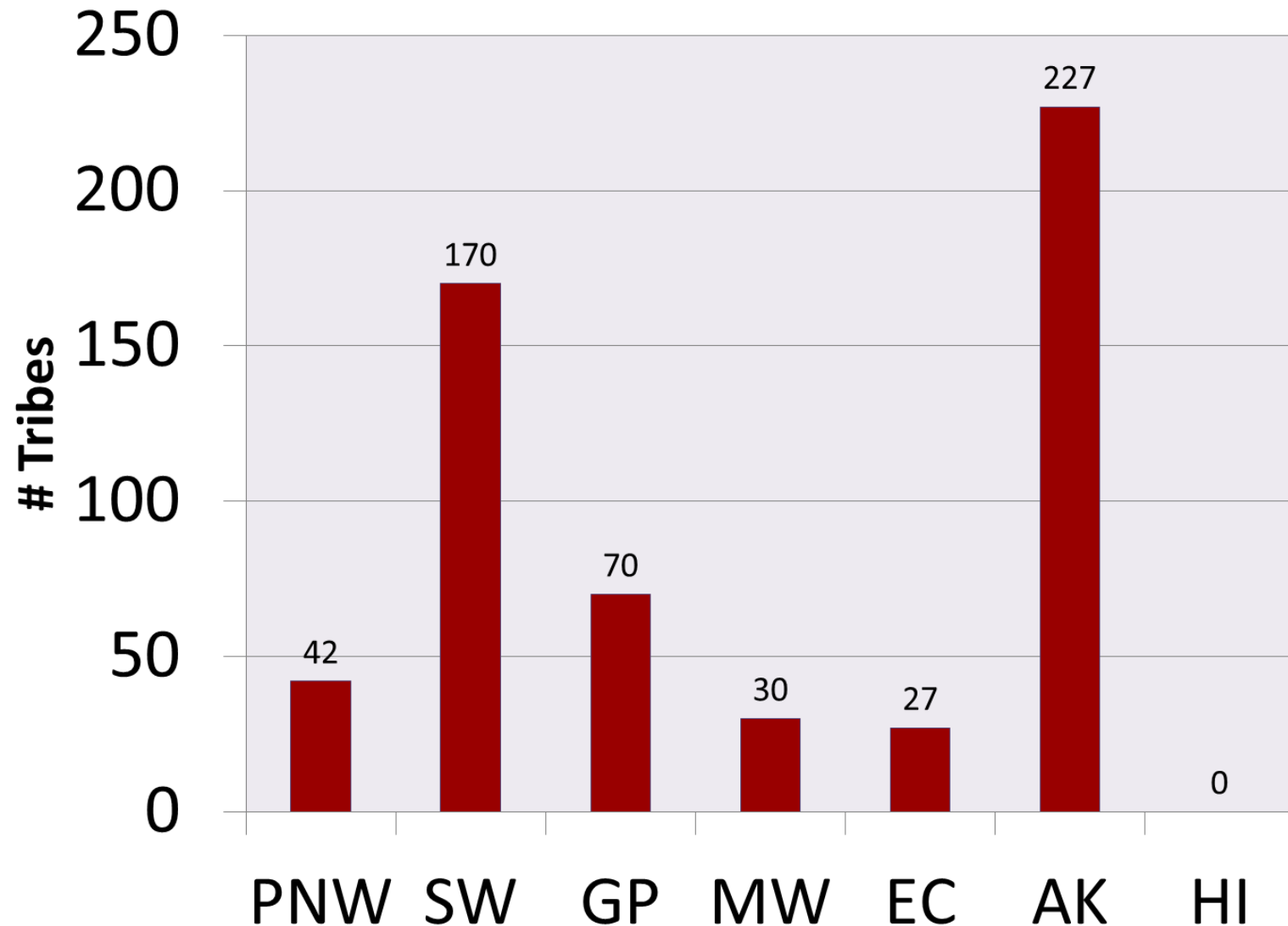
Impacted Tribes



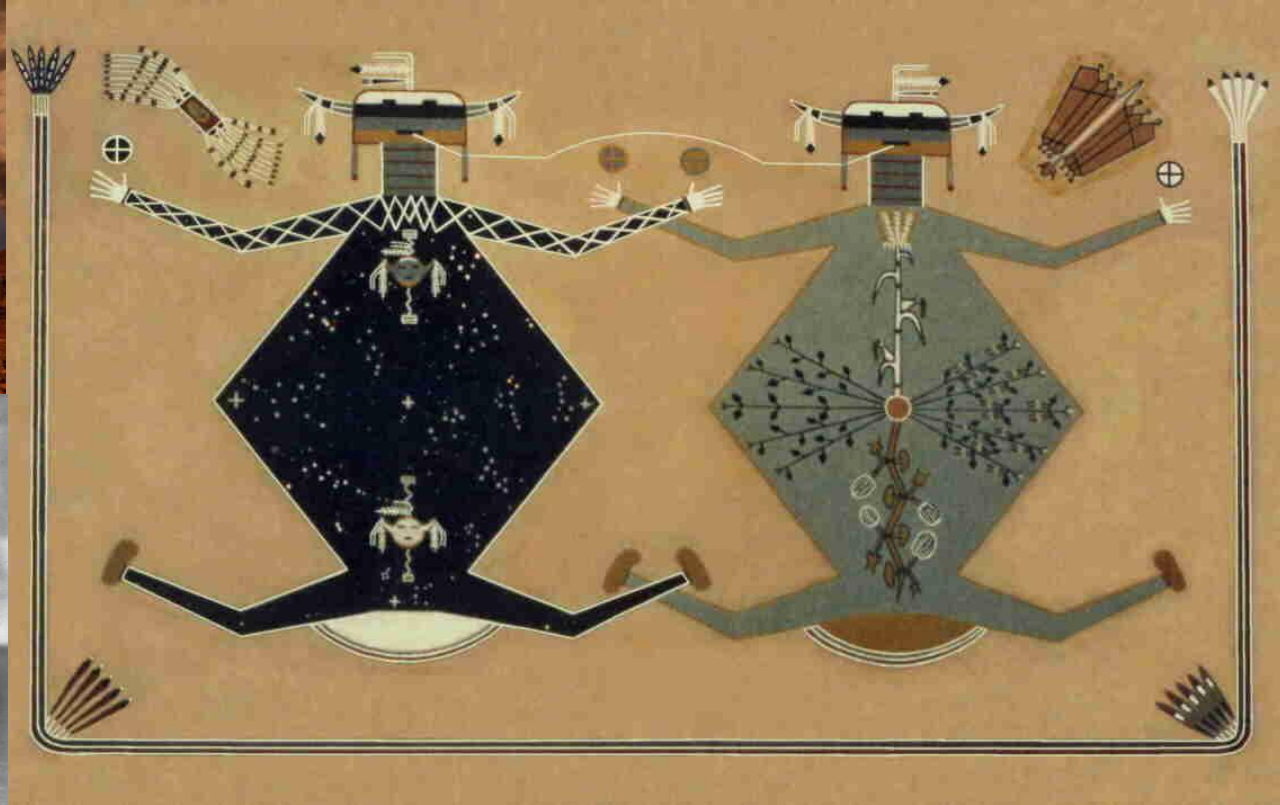
Impacted Tribes



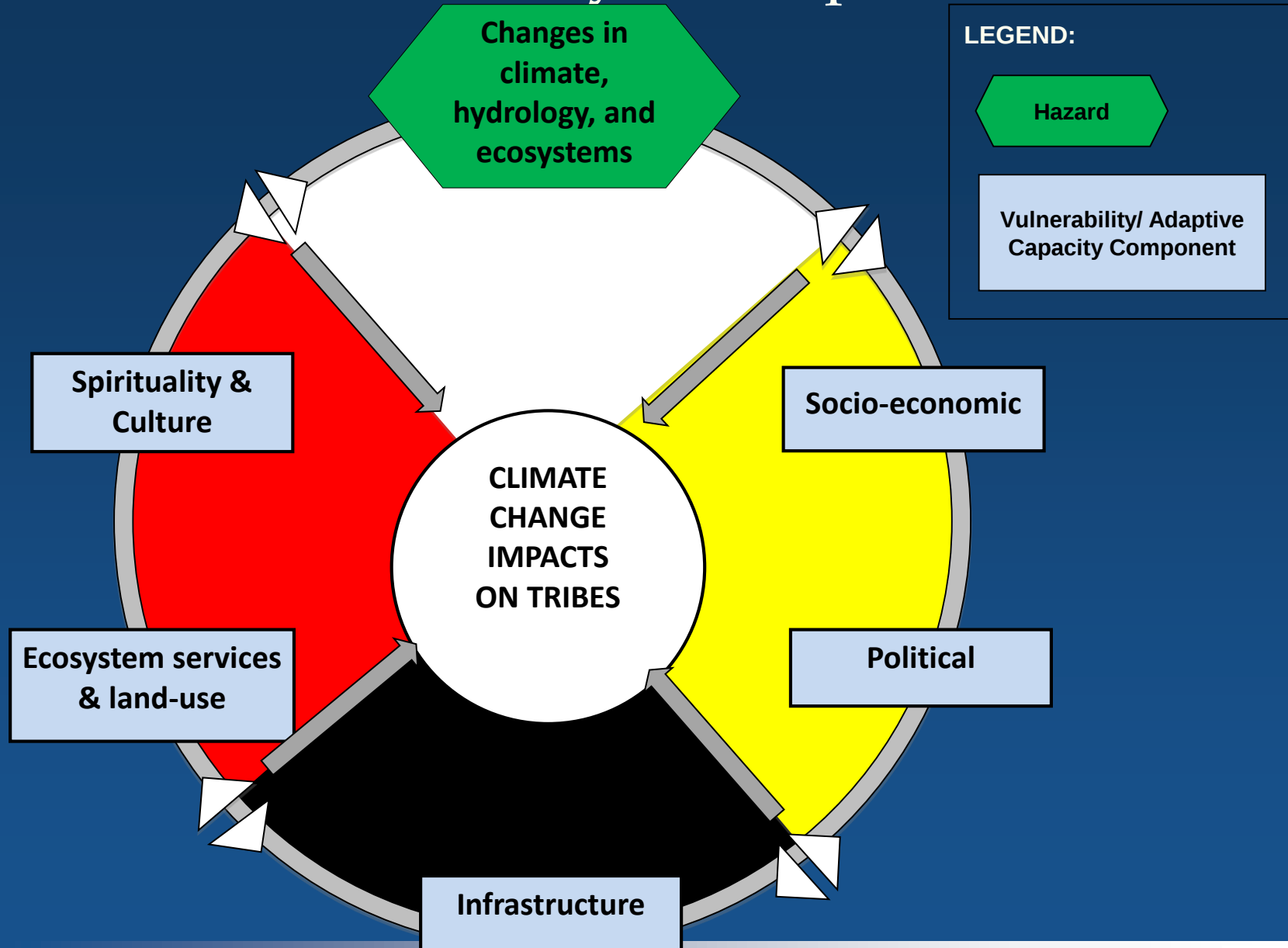
566 Federally Recognized Tribes



Water is Sacred



Hazard & Vulnerability Conceptual Model



Climate, hydrologic, & ecosystem

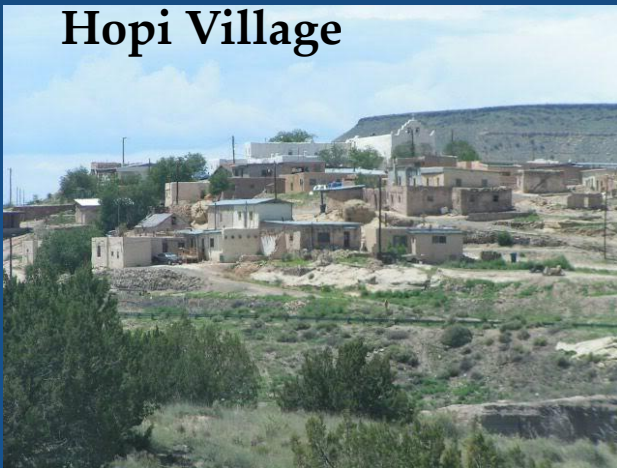


Continental & Mountainous Regions (including AK)	Great Lakes	Coastal Regions & Islands (including AK)	Additional changes in AK
Shifts in winter precipitation from snow to rain	Overall substantial decreases in extent of ice coverage	Sea level rise & coastal inundation	Changes in Arctic sea ice
Shifts to earlier snowmelt	Warming of temperatures in some lakes	Increasing saltwater intrusion	Increases in permafrost thawing
Increases in river T	Water levels in Lakes Michigan and Huron at record lows and levels in other lakes continuing to drop	Rising ocean temperatures	Increasing river turbidity
Shifts to earlier lake & river ice breakup and later lake and river ice freeze up		Increasing ocean acidification	Increasing river erosion
Accelerating glacial retreat, particularly in AK and the Pacific NW		Increasing coastal erosion	Lake drying
Increases in drought particularly in the southern U.S.		Increases in intense tropical cyclone activity (i.e. tropical storms, hurricanes)	
Increases in storm intensities, which will affect flooding		Expanding coastal dead zones	

Socio-economic Factors

- 69% of AIAN communities < 2,000 people and 78% in rural
- Higher water supply costs because of greater transportation costs and smaller economies of scale
- 15% unemployment is nearly double U.S.
- Household income is \$33,379 or 36 % below U.S.
- 29% live below poverty line
- 24%, 25 years and older not graduated from high school
- Economic and education conditions affect management of tribal water resources

Hopi Village



Newtok Alaskan Village



Socio-economic Factors

Examples

- NAU-ITEP Tribal Water Resources Management continuing education online course – Sept. 2014
- Tribal colleges - Introduction to Climate Change from an Indigenous Perspective course – American Indian Higher Education Council
- Lakota Funds business microloans - Pine Ridge Indian Reservation



Political Factors



- Sovereign tribes
- Reservations with fixed boundaries & remnant of traditional territory
- Off-reservation sustenance rights
- Defining Federal Reserved Water Rights
- Off-reservation pollution and impacts
- Underrepresented in management discussions
- Environmental CC impacts mixed with legal=complex



Crow Tribe Water Settlement 2010

Political Factors

Examples

- 1990 Fort Hall Indian Water Rights Settlement (ID)
 - ✓ Discussion of water sources during times of shortage (Colby et al. 2005)
 - ✓ Allows portion of tribal water rights to be used for fish, wildlife, environment (Colby et al. 2005)
- June 11, 2009 Intergovernmental Accord between the Tribal Leaders of the Federally Recognized Indian Tribes in Michigan and the Governor of the State of Michigan to Address the Crucial Issue of Climate Change



**Intergovernmental Accord between the
Tribal Leaders of the Federally Recognized Indian Tribes in Michigan
and the
Governor of the State of Michigan
to Address the Crucial Issue of Climate Change**

Whereas, the Tribal leaders of the federally recognized Indian Tribes in Michigan and the Governor of the state of Michigan recognize the vital importance of the health and quality of the Great Lakes, inland waters, air, geography, ecosystems, plants, and wildlife to the physical, cultural, and economic welfare and future of all of our citizens;

Infrastructure Factors



- Not designed to accommodate changing hydrologic and ecologic regimes resulting in deterioration and effectiveness
- Resulting in economic and public health consequences
- Increases costs of providing water
- Lacking, inadequate, or poorly maintained increasing vulnerability to flooding, drought, and waterborne diseases
- 12% of AIAN homes lack safe & adequate water supplies & waste disposal system (1% is US average)
- 13% in AK and 25–40 % on Navajo haul water



Infrastructure Factors



Example

Hualapai Tribe (AZ) preparing for water shortages

- Water catchment-storage units
 - Catchment area lined w/ asphalt mat
 - 50,000 gallon stock tank
- Removal of non-native tamarisk, which consume large amounts of groundwater and replacement with willows from willow nursery
- Installation of new wells and pipelines

Environmental & Land-use Factors

- Climate changes in ecosystem affect ecosystem services
- Subsistence activities, cultural and religious activates, gathering herbs and medicine
- 93% of AI and 66% of AN rely on groundwater for drinking
- Degradation due to depressed economic conditions, fixed marginal lands, urbanization, land-use changes invasive spaces



Environmental & Land-use Factors

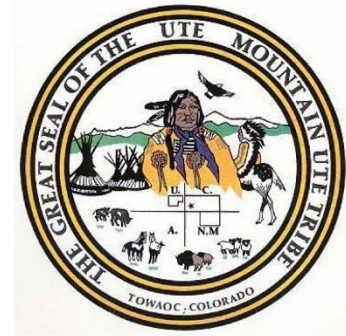
Example

Ute Mountain Ute, CO Groundwater Protection Plan

- Discusses factors like pesticide use, storage of petroleum products, emergency spill response, monitoring related to off-reservation uranium mill
- Different recommendations for different zones – e.g., Ute Mountain area is important spiritually and culturally – uses of toxic substances prohibited unless Council determines a use is justified

Ute Mountain Ute Tribe

Ground Water Protection Plan



March 2004

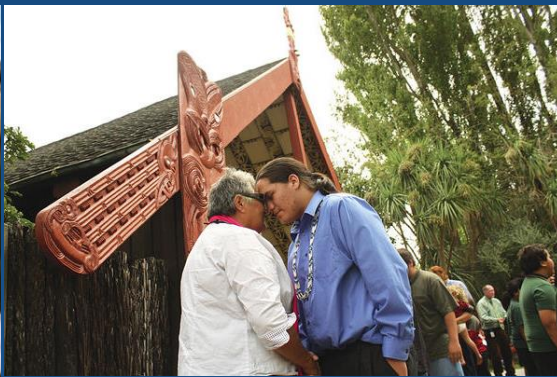
Prepared by Mountaintop Associates, Inc.
P. O. Box 1563, Bozeman, MT 59771 (406)-585-3501
And the Ute Mountain Ute Tribe's Environmental Programs Department

i

Spiritual and cultural factors



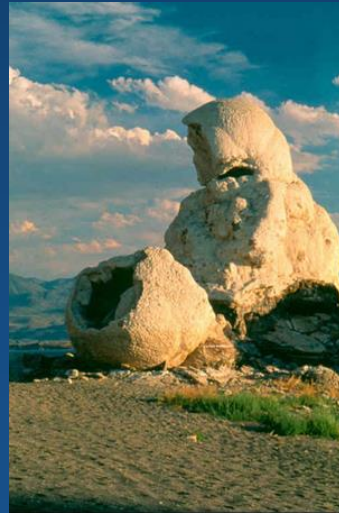
- Intimately connected to their environment through identity, livelihoods, spiritual beliefs, and cultural values.
- Holistic perspective of Mother Earth, Father Sky, and the spiritual beings within
- Ecological knowledge is a repository of long-term observation of environmental changes and contributes to adaptive capacity



Spiritual and cultural factors

Example

- Pyramid Lake is home to cui cui - endangered fish species that is the primary cultural resource of Pyramid Lake Paiute (NV)
- Cui cui respond to seasonal freshwater signal to migrate upriver and spawn.
- Drought could potentially interfere with this signal and affect reproduction.
- This could have cultural effects as well as effects on ecosystem services.



Impacts



Impacts - Water supply

Alaska

- Warmer temperatures may be contributing to algal blooms (e.g. Pt. Hope)
- Permafrost thaw – some lake water levels declining/ disappearing; causing infrastructure damage
- Beaver which carry giardia, now occupying northern Alaska for first time since last ice age.



Children in the village of Selawik, Alaska play on an insulated water line.
Photo by Mike Brubaker

Impacts - Water supply

Great Plains – Drought caused water levels to drop clogging sole intake pipe for water supply for Standing Rock Sioux, ND



Navajo home of elderly woman, who has no running water or electricity and who hauls water from a community well five miles away and stores water in steel barrels. Photo by: Karletta Chief.

Southwest - On the Navajo Reservation (AZ, NM, UT) an estimated 25-40% of people haul water, during drought costs of hauling water may double



Impacts - aquatic species

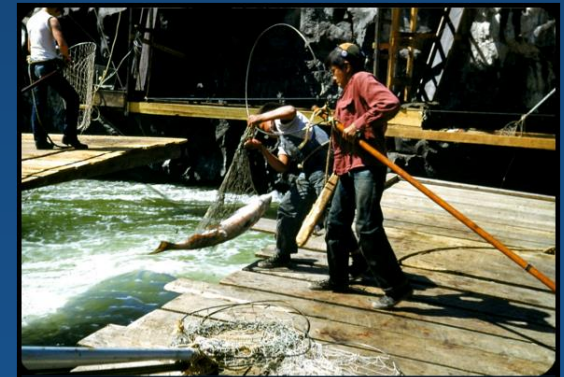
Pacific Northwest

Salmon are First Foods important both for culture and as food. Already facing overfishing, hydroelectric dams, invasive species – may face additional challenges

- Increasing storm intensities → scouring of fish eggs
- Warmer water temperatures
 - Earlier emergence of fry – potential mismatches with food supply
 - Salmon might migrate earlier but could be mismatch with downstream conditions
 - Return migration affected in 2003 at Bonneville Dam, Columbia River



First Salmon Ceremony at the Celilo Longhouse. Photo provided by Columbia River Intertribal Fish Commission



Boys fishing for Fall Chinook salmon at Celilo Falls . Photo provided by Columbia River Intertribal Fish Commission.

Impacts - aquatic species

East

For some tribes in Northeast such as the Pleasant Point Passamaquoddy in Maine, lobster are important

- Warmer water temperatures
 - Could boost productivity in some locations
 - However, may be more hospitable for a bacterial condition known as lobster shell disease
- Ocean acidification
 - Concerns (like on West Coast) about potential impacts on shell development in shellfish



Impacts - aquatic species

Midwest

Wild rice (manoomin) is sacred food of great importance to the Anishinabe tribes of the Great Lakes area

- Affected by factors such as mining, dams and agricultural ditch networks
- Warmer water temperatures – could reduce seed dormancy and favor invasive, outcompeting plants and invasive carp
- Water levels - 2009 low Lake Superior water levels – forced Bad River to cancel annual harvest; 2012 flood – near total crop failure on the Fond du Lac Reservation



Impacts - ranching and agriculture from droughts, floods, earlier snowmelt

- Southwest – Drought - early 2000s
– Hualapai (AZ) – multiyear drought had to sell off 500 cattle because of supplemental water/feed costs
- Great Plains - In 2011, historic drought and heat wave in Oklahoma – difficulties producing hay – farmers forced to sell their livestock prematurely, markets were depressed from accelerated selloff.



Impacts - ranching and agriculture from droughts, floods, earlier snowmelt

- Great Plains – In Feb. 2011, Pine Ridge Reservation (SD) flooding due to warm air temps leading premature snowmelt, combined with ice jams and clogged culverts
- Great Plains – Earlier snowmelt – concerns for Wind River Reservation (WY) about having sufficient water for late season irrigation



Impacts - tribal sovereignty

Everywhere – Climate change impacts on water quantity, quality, and timing + population growth are leading to concerns that Indian water rights may be sacrificed



Pacific Northwest – Moving species - tribes like Tulalip (WA) concerned that may be mismatch between species movements and locations of tribal access



Impacts - soil quality (e.g., erosion prompting tribal relocation)

Alaska

- Delays in development of sea ice combined with storm surges → more erosion + population growth - Kivalina is considering relocation
- Permafrost thawing → riverine erosion – Newtok on Ninglick River actively trying to relocate



**Shishmaref house
undermined by coastal
erosion**

Impacts - soil quality (e.g., erosion prompting tribal relocation)

Pacific Northwest

- Increased frequency of winter storms + high tides, sea level rise
→ high storm surges and erosion
- The Quileute are considering relocation. The Hoh are relocating to National Park Service land



Impacts - soil quality (e.g., erosion prompting tribal relocation)

East

- Oil and gas development and canals + Hurricanes Katrina and Rita + Mississippi levee system, sea level rise can also contribute → loss of land for Louisiana tribes.



Isle de Jean Charles,
1963. Imaged provided
by the USGS and Julie
Maldonado



Isle de Jean Charles,
2010. Imaged provided
by the USGS and Julie
Maldonado



Photos by Babs Bagwell.

Impacts - soil quality (e.g., from drought-related land degradation)

Southwest

- Droughts - migrating sand dunes burying homes; causing transportation problems, contributing to loss of endangered native plants and grazing lands.



Adaptation

- Tribes have urgent need to **prepare for and respond** to climate change impacts and to do so in a way that considers cultural and traditional values.
- Adaptation strategies can stand alone however may be more effective if **integrated** into a broader sustainability agenda and climate change considerations can be included as part of planning and implementation that is already occurring

Adaptation

- Economic development plans
- Ecosystem management plans
- Water rights settlements
- Emergency response (short-term) and mitigation (long-term) plans to prepare for and lessen the impacts of climate extremes such as droughts, flooding, heat waves
- Public health plans
- Long-term water supply management strategies
- Reservoir operation plans
- Stormwater management plans
- Water supply contingency plans - to ensure water security in times of disaster, shortage, or disturbance
- Infrastructure upgrades
- Infrastructure construction as part of new development or after a natural disaster has occurred

Adaptation

- Since impacts are interconnected, adaptation processes must use a **holistic approach**
 - Across sectors (e.g. municipal water, agricultural water, energy)
 - Across time (future generations)
 - Across space
 - Across populations (distribution of benefits/costs), vulnerable subpopulations
 - Across the environment
 - Across decision-making scales (local, national)

Adaptation

- **Uncertainties in predicting** impacts because of uncertainty in model projections, lack of community-specific climate and water resources data, and unpredictable interactions among changes, impacts, and factors
 - **Need to manage water resources under increasing uncertainty**
- Adaptation process needs to be **flexible, iterative**, and include relevant **monitoring** to allow for **continual evaluation** of our understandings of impacts and the effectiveness of adaptation strategies.

Adaptation

- For AIAN, who have often been left out of discussions, it is also important that adaptation planning be **participatory and transparent**.

Acknowledgements

Colorado

University of Colorado at Boulder

CLIMATE IMPACTS ON PUBLIC LANDS

Four Corners Focus - Arizona, Colorado, New Mexico, Utah



NORTHERN
ARIZONA
UNIVERSITY



Institute for
Tribal
Environmental
Professionals

Intertribal COUP

INTERTRIBAL COUNCIL ON UTILITY POLICY

Tribes Building Sustainable Homeland Economies



ALASKA NATIVE TRIBAL HEALTH CONSORTIUM

leaders in life care

Center for Climate and Health

*Staplets Consulting
LLC Boulder, CO*



Columbia River
Inter-tribal Fish
Commission



Native Communities
and Climate Change

<http://www.tribesandclimatechange.org>

CIRES
Cooperative Institute for Research in Environmental Sciences



NATIONAL DISASTER PREPAREDNESS
TRAINING CENTER at the University of Hawai'i



Climate Change and Indigenous Peoples in the United States: Impacts, Experiences and Actions

Read about it in the Special Issue of Climatic Change in October 2013. link.springer.com/journal/10584

