



WAMPUM Adaptation framework: eastern coastal Tribal Nations and sea level rise impacts on water security

Kelsey Leonard

To cite this article: Kelsey Leonard (2021): WAMPUM Adaptation framework: eastern coastal Tribal Nations and sea level rise impacts on water security, Climate and Development, DOI: [10.1080/17565529.2020.1862739](https://doi.org/10.1080/17565529.2020.1862739)

To link to this article: <https://doi.org/10.1080/17565529.2020.1862739>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 30 Jan 2021.



Submit your article to this journal [↗](#)



Article views: 1305



View related articles [↗](#)



View Crossmark data [↗](#)

WAMPUM Adaptation framework: eastern coastal Tribal Nations and sea level rise impacts on water security

Kelsey Leonard 

Faculty of Environment, University of Waterloo, Waterloo, Canada

ABSTRACT

Sea level rise (SLR) poses significant threats to northeast and mid-Atlantic Tribal Nations' climate and water justice. Existing SLR adaptation frameworks do not include Indigenous knowledge. Furthermore, SLR adaptation policy prioritizes economic and property rights and is misaligned with Indigenous coastal protection priorities. If Tribal Nations are to respond effectively to SLR then adaptation frameworks must be designed and developed by Indigenous Peoples for Indigenous Peoples. Eastern coastal Tribal Nations have a unique history of survival and resilience despite settler-colonial expansion in the northeast and mid-Atlantic regions of what is currently referred to as the United States. Experiences of eastern Atlantic coastal Tribal Nations highlight innovative response strategies for SLR adaptation and coastal stewardship practices not reflected in existing adaptation frameworks for the region. Indigenist SLR adaptation frameworks that utilize Indigenous knowledge are needed to combat water security issues resulting from SLR risks such as flooding, saltwater intrusion, storm surge, and erosion. This article proposes the WAMPUM adaptation framework informed by northeastern and mid-Atlantic coastal Tribal Nation science and knowledge systems for climate change adaptation to SLR.

ARTICLE HISTORY

Received 18 June 2020
Accepted 5 December 2020

KEYWORDS

Adaptation; sea level rise; climate change; Indigenous Peoples; water security

1. Introduction

Globally sea level rise (SLR) adaptation frameworks fail to include Indigenous Peoples or knowledge in the development of adaptation measures. This article introduces a unique set of adaptation principles reflective of Indigenous resilience over millennia in Atlantic coastal areas that can guide international, national, and regional adaptation efforts moving forward. The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change found that coastal communities will be severely impacted by sea level rise (SLR) facing displacement due to land loss by 2100 (Wong et al., 2014). Climate change and associated impacts are persistent challenges to Indigenous water security. The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) recognizes Indigenous Peoples right to self-determination including rights to Indigenous water justice (Robison et al., 2018). SLR has been increasing globally since the mid-twentieth century (Dangendorf et al., 2019) and in what is currently known as the United States east coast climate change is exacerbating issues of rising sea levels for coastal communities (Beckman & Garcia, 2019; Marsooli et al., 2019). SLR generated by anthropogenic climate change (ocean expansion and glacial melt) already and will continue to have significant impacts (cultural, economic, social, ecological, political, health and spiritual) on coastal Tribal Nations of Turtle Island (North America) (Jantarasami et al., 2018; Marino, 2018; Wildcat, 2013). SLR projections in the northeast and mid-Atlantic

models predict a rise of sea levels by as much as 12 inches by 2050 and 29 inches by 2080 and within a rapid ice melt scenario sea levels could rise in the region by as much as 6.5 feet by 2100 (EPA, 2014; Sweet et al., 2017). Sea level rise presents increased risks to coastal communities including flooding, storm surge, saltwater intrusion, wetland loss, erosion and inundation with vast implications for regional security (Church et al., 2013; Kopp, 2013; Nicholls, 2018; Woodruff et al., 2013; Xie et al., 2019; Yin et al., 2009). The Fourth National Climate Assessment of the U.S. Global Change Research Program identified that SLR threatens Tribal Nations' abilities to 'pursue a mix of traditional subsistence and commercial sector activities that include agriculture, hunting and gathering, fisheries, forestry, energy, recreation, and tourism enterprises' (Jantarasami et al., 2018, p. 579). SLR will exacerbate inequality and jeopardizes Tribal Nations' infrastructure, including water systems, as well as cultural resources vital to sovereign integrity (Jantarasami et al., 2018; Nash & Wholey, 2018).

Indigenous scholars and scientists have identified the unique challenges facing Indigenous Peoples and nations adapting to climate change and the compounded injustice of combating settler colonialism alongside a climate crisis (Maldonado et al., 2013; Whyte, 2016). Although there have been recent studies on climate change impacts for Tribal Nations across Turtle Island (Maldonado et al., 2016; McNeeley, 2017; Whyte et al., 2016; Wildcat, 2013) to date there have

been limited studies on the impacts of climate change and SLR on Tribal Nations located along the Atlantic coast of what is currently known as the United States (Cozzetto et al., 2013). Eastern coastal Tribal Nations have fewer climate change adaptation plans compared to coastal Tribal Nations in other regions of the U.S. such as Alaska and the Northwest (Norton-Smith et al., 2016). Regional climate change studies of the Northeast and Mid-Atlantic (Moser et al., 2008) as well as state level studies of Connecticut, Delaware, Maine, Massachusetts, Maryland, New Jersey, New Hampshire, New York, Pennsylvania, Rhode Island and Virginia have little to no mention of Indigenous Peoples (Epanchin-Niell et al., 2017; Fu, 2020; Gornitz et al., 2020; Taylor et al., 2020). Moreover, previous studies that may mention Tribal Nations located within the region do not consider Indigenous knowledge or perspectives on SLR adaptation measures.

There are numerous federally recognized and state recognized coastal Tribal Nations in the northeastern and mid-Atlantic regions with additional urban Indigenous communities throughout U.S. eastern coastal cities (See Figure 1). For example, New York City has the largest population of Native Americans and Alaska Natives of any city in the U.S. with 112,000 individuals (Norris et al., 2012). Eastern coastal Tribal Nations and Indigenous communities have a unique history and ecological connection to the coastal areas and waters. The primary focus of this viewpoint article is to provide a new framework for Indigenous adaptation measures to sea level rise that advance Indigenous water security utilizing eastern coastal Indigenous knowledge systems and ways of knowing. Indigenous scholars and others have noted how Indigenous adaptive capacity is often misinterpreted through the lens of western colonial adaptation frameworks and many climate change studies use deficit language of vulnerability, risk, and extinction and fail to account for Indigenous knowledge and innovation (Belfer et al., 2017; Reo et al., 2017). As Cameron (2012) notes scholars must examine whether existing climate change studies adequately assess the impact of colonialism on current practices and policies in response to environmental change. Current SLR adaptation measures are not ‘politically neutral routines and procedures’ they represent contemporary exercises of ‘colonial power’ especially given the absence of Indigenous voices in the design and conceptualization (Cameron, 2012, p. 111). Dismantling colonial power structures in ocean and coastal management requires new SLR adaptation strategies that are not only inclusive of but designed by Indigenous Peoples. The article presents a decolonial and Indigenist SLR adaptation framework, the WAMPUM framework, centering Indigenous knowledge systems and experiences of northeastern and mid-Atlantic coastal Tribal Nations.

2. Sea level rise adaptation

Sea level rise (SLR) exacerbates flooding, storm surge, erosion and salinization of land and water among other impacts. Scientists have determined that communities already experiencing increasing SLR will only continue to suffer impacts in the future due to anthropogenic climate change (IPCC, 2012). SLR adaptation measures in non-Indigenous communities

are generally conceived of in response to risk and economic hardships imposed by climate change, and successful adaptation is often viewed as a high-cost process to the benefit of the wealthy (Siders & Keenan, 2020). As such, existing adaptation frameworks favour property owners and urban areas with high tax bases to implement adaptation measures such as relocation and built infrastructure (Jurjonas & Seekamp, 2018). Jurjonas et al. (2020) note that existing adaptation strategies are shaped by ‘ethnocentrism, power, and privilege’ (p. 1). There are no present SLR adaptation frameworks that integrate eastern Atlantic coastal Indigenous knowledge for SLR adaptation for water security or incorporate socio-cultural valuations in SLR risk assessment.

Some of the existing adaptation frameworks for sea level rise include ‘PARA’ protect, accommodate, retreat, avoid (Doberstein et al., 2020) and ‘AAN’ armouring, acquisition, and nourishment (Siders & Keenan, 2020). Additional non-Indigenous adaptation measures commonly referenced for SLR include planning, protection, accommodation, and managed retreat (Fu, 2020; Gibbs, 2016; Klein et al., 2001; Tol et al., 2008). Planning reflects the planning activity such as climate change or hazard mitigation plan that is developed to address SLR. Protection measures are engineering solutions designed to reduce SLR risks and include actions such as seawalls, living shorelines, beach nourishment, etc. Accommodation measures work to change human uses of coastal areas through actions including new zoning laws, infrastructure elevation, etc. (Fu, 2020). Managed retreat or relocation is the process by which the shoreline is allowed to naturally evolve and human infrastructure and uses are moved to safer areas through actions such as voluntary buy out programmes and community relocations (Fu, 2020; Marino, 2018). Nicholls (2018) notes that the response strategy of ‘attack’ is also being utilized to reclaim land and promote seaward and upward development. The militarized and combative language utilized in predominantly western SLR adaptation typology is antithetical to Indigenous epistemologies for adaptation to environmental change that centres on kinship, relationality and ecocentric value systems (McGregor et al., 2020; Reo et al., 2017; Whyte, 2017). Siders and Keenan (2020) note that the reasoning behind selection of certain adaptation measures over others by coastal managers is largely understudied. However, those studies that do attempt to understand coastal manager decision-making do not include coastal managers and directors of Tribal Nation Environmental Departments concentrating rather on individuals within positions of city, state, federal or municipal government. Why are Tribal Nations not being included in the SLR research and adaptation frameworks?

Marino (2018) suggests the concept of ‘adaptation oppression’ to highlight western scientific and cultural biases reflected in the limited adaptation options present in existing frameworks (p. 12). Additionally, within the process of adaptation oppression Marino (2018) identifies three key aspects of western colonial ethnocentrism that contribute to the contemporary oppressive limitations of existing adaptation frameworks for Indigenous Peoples: (1) western property law systems exclude Indigenous owners; (2) market and economic valuations commodify the natural world solely for human benefit; and (3) settler-colonial individualism undermines

Northeast and Mid-Atlantic Tribal Nations



Figure 1. Northeastern and Mid-Atlantic Tribal Nations.

The map depicts the federally recognized Tribal Nations in the northeast and mid-Atlantic regions. However, not listed are state recognized Tribes, federally recognized Tribes with historical ties to the region (but due to colonization no longer have land holdings in the region), and other non-reservation Indigenous communities including urban Indigenous communities all of which have a range of potential associated water security climate change impacts due to SLR. The map is adapted from the Northeast Climate Science Center Tribal Partners programme (<https://necsc.umass.edu/indigenous-peoples-and-tribal-partners>).

Indigenous nationhood, kinship and sovereignty (p. 12). Hardy et al. (2017) underscore that existing processes for developing response strategies to climate change are ‘color-blind adaptation planning’ that ‘overlook racial inequality’ and systemic racism in environmental governance institutions (p. 62). Existing SLR Adaptation typologies of the U.S. National Oceanic and Atmospheric Administration, Federal Emergency Management Agency, and U.S. Army Corp of Engineers do not include Indigenous knowledge showcasing institutional bias and inherited intellectual colonialism (Bridges et al., 2015; NOAA, 2010). At the international level, the Organisation for Economic Co-operation and Development (OECD) and the United Nation’s Intergovernmental Panel on Climate Change (IPCC) both advocate for SLR adaptation frameworks that also do not include Indigenous Peoples or knowledge (OECD, 2019; Wong et al., 2014). Although there is growing momentum for nature based solutions (Arkema et al., 2017; van der Nat et al., 2016), many of the ‘hard’ adaptation strategies for SLR focus on engineering and built infrastructure solutions (Jurjonas & Seekamp, 2020) and are misaligned with Indigenous ways of knowing as they do not account for ecosystem based management or prioritize non-human relations and environment over human benefits and use.

In 2019 the IPCC published the Special Report on the Ocean and Cryosphere in a Changing Climate. For the first time Chapter 4 on ‘Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities’ highlighted the importance of Indigenous Knowledge for building adaptive capacity for SLR (Oppenheimer et al., 2019). Despite these advancements current SLR adaptation frameworks for the northeast and mid-Atlantic coastal regions do not include Indigenous Peoples or knowledge; and they often do not consider the cultural, social, political, or spiritual impacts of SLR on Indigenous communities or Tribal Nations. Without indicators of relevance and importance to Indigenous Peoples SLR studies will not accurately measure impacts on Indigenous communities and consequently will fail to develop adaption options that respond to the unique needs of Tribal Nations. Therefore, Indigenous designed adaptation frameworks are needed that are a cultural match for distinct Tribal Nations and climatic zones.

3. Northeastern and mid-Atlantic Tribal Nations

Tribal Nations in the northeast and mid-Atlantic are often referred to as first contact Tribes recognizing their long history of co-existence with settler-colonial societies who landed on

eastern shores prior to westward colonization. As such the examination of SLR impacts to water security for Tribal Nations in these regions is ideal given their resilient history of coastal management and continued stewardship of the area. Tribal Nations are sovereigns with the inherent 'authority to address climate change as an important issue that affects their lands, resources, and traditional practices' (Redsteer et al., 2013, p. 388). There are 24 Federally Recognized Tribes (Federal Register 2020, see Figure 1) in the Northeast and Mid-Atlantic regions of what is currently referred to as the United States. There are additional state recognized Tribal Nations in the region and non-recognized Indigenous communities.

Most of the northeast and mid-Atlantic Tribal Nations have territory within the Low-Elevation Coastal Zone (LE CZ) and face severe water security threats to due climate change and sea level rise. Eastern coastal Tribal Nation territories and reservations are ancestral homelands as many Tribes were never removed or relocated unlike some of the Tribal lands and reservations established west of the Mississippi River. However, population growth among the eastern coastal Tribal Nations in the past century has exacerbated SLR vulnerabilities as available livable land to accommodate population expansion continues to decrease. Additionally, unlike non-Indigenous communities Tribal Nations face many political and legal obstacles to relocation and acquisition of new lands for SLR Adaptation. SLR presents distinct risks for coastal Tribal Nations in the northeast and mid-Atlantic namely that if climate change projections are accurate, and sea levels rise by 1–2 m by 2100, most existing Tribal territories and reservations will be inundated and likely unlivable in the next century. With increased extreme high tides and storms Tribal Nations are experiencing greater levels of erosion and saltwater intrusion impacting water resources and infrastructure.

Under the Clean Water Act and as approved by the U.S. Environmental Protection Agency Tribal Nations may apply for Treatment as a State (TAS) status to administer water quality standards (WQS) for water resource protection. While more than 60 Tribal Nations from other regions of the U.S. have been granted TAS for the WQS Program, none of the northeastern or mid-Atlantic coastal Tribal Nations have been granted TAS status for WQS (EPA, 2020); and the Penobscot Nation has been awaiting approval of their WQS programme since 2014. Disparate treatment of eastern Tribal Nations and the need for unity to scale up resources and political strength in dealings with the U.S. federal government was at the core of the foundation of United South and Eastern Tribes, Inc. (USET) in 1968 (USET, 2020b). USET, a non-profit, inter-tribal organization, provides technical assistance for climate resiliency including water and wastewater utility management for federally recognized Tribal Nations in the region (USET, 2020a). Additionally, the Bureau of Indian Affairs Tribal Resilience Program provides funding for federally recognized Tribes to build capacity related to ocean and coastal management, climate change and SLR. The Mashantucket Pequot Tribe received funding for a climate change vulnerability assessment and the Wampanoag Tribe of Gay Head (Aquinnah) received an award to develop a strategic plan for SLR and climate change adaptation (BIA, 2020). Despite

these resiliency efforts there remain unmet needs among eastern coastal Tribal Nations to address the impacts of SLR on water infrastructure.

4. Sea level rise impacts on water infrastructure

Tribal Nations along the eastern Atlantic coast face significant threats to water infrastructure due to SLR including land loss, saltwater intrusion, flooding, and wastewater treatment concerns. Non-indigenous population growth in combination with SLR poses unique threats to Indigenous water security as fresh water supplies are under increasing stress due to increased demand resulting from sprawling development in coastal areas surrounding Tribal Nation reservations and territories and projected SLR induced migration (Hauer, 2017; Neumann et al., 2015; Sanchez et al., 2020). Moreover, Tribal Nation population growth is also increasing, but available land is not. Reservations are limited geographies due to the settler-colonial state with limited opportunities for acquisition or reclamation of ancestral Indigenous lands. With limited land availability Tribal Nation freshwater supplies may not be able to support continued population growth especially if supplies are further diminished by SLR.

Tribal Nations in the northeast and mid-Atlantic rely on coastal aquifers to meet drinking water supply but SLR increases the threat of salinization of water supplies due to saltwater intrusion (Jurjonas & Seekamp, 2018). Many Indigenous Peoples in northeastern and mid-Atlantic coastal regions of the U.S. lack access to adequate water infrastructure and Indigenous residents of Tribal reservations often rely on private wells and septic systems vulnerable to not only climatic changes but contamination because of jurisdictional failures and environmental racism (Ravichandran, 2015; USGS, 2020). Saltwater intrusion increases with SLR and jeopardizes groundwater supplies through salinization of freshwater aquifers reducing available water quantity and quality and threatening Indigenous coastal water security (EPA, 2016). Tribal Nation water infrastructure is further threatened by coastal flooding. With increases in flooding event frequency and intensity water infrastructure has limited opportunity for response to one event before another extreme flooding event may cripple the system. This was an issue for communities throughout the northeast and mid-Atlantic during Superstorm Sandy in 2012 and Tribal Nations were also impacted at that time. Power disruptions during Sandy further exacerbated water security issues for Tribal Nations and flooding inundated low-lying roads making system repairs and emergency response more difficult (EPA, 2016).

Wastewater infrastructure poses additional threats to Indigenous water security. Many eastern coastal Tribal Nations have septic systems that will require infrastructure improvements to be more resilient to SLR and storm surge. Wastewater contamination of drinking water supplies due to failed septic systems because of SLR is an increasing concern for Tribal Nations. Flooding exacerbated by SLR creates extreme events that could allow contaminants from septic systems to enter ground and surface waters within Tribal Nations reducing water quality and quantity for daily livelihood needs (EPA, 2016). Indian Health Services currently works with Tribal

Nations throughout the northeast and mid-Atlantic to improve water and sanitation infrastructure, but current funding allocations are not sufficient for meeting all current water security needs in response to SLR. Northeast and mid-Atlantic Tribal Nations face distinct challenges to water security given increasing SLR threats (land loss, saltwater intrusion, flooding, wastewater treatment) and require an Indigenous SLR adaptation framework that prioritizes Indigenous adaptation options.

5. A path forward: WAMPUM Indigenous adaptation framework for sea level rise

The combination of climate and water injustices facing Tribal Nations in coastal areas requires the development of more robust and culturally informed adaptation frameworks that are reflective of the communities implementing the adaptation measures. Continued use of adaptation frameworks that are not created by and for Indigenous Peoples in response to SLR for Indigenous water security only further adaptation oppression. Northeastern and mid-Atlantic Tribal Nations need an adaptation framework that is informed by eastern coastal Indigenous knowledge systems. The proposed WAMPUM Adaptation Framework for Sea Level Rise (Figure 2) builds on lessons of eastern coastal Tribal Nations SLR risks and provides adaptation measures that are guided by Indigenous knowledge systems. *Wampum* refers to carved quahog and whelk shells harvested by Indigenous Nations along the Atlantic coast and used throughout history as currency and to form treaty relationships between Indigenous and settler peoples. Across eastern portions of Turtle Island (North America), terms of governance and treaty relationships, such as the Two Row Wampum – *Kaswentha*, were constituted by a wampum belt (Ransom & Ettenger, 2001). Through an extensive Indigenous socioeconomic and political system, wampum forms the foundation of historical and contemporary understandings of sustainability for many Indigenous Nations. The WAMPUM adaptation framework synthesizes current adaptation measures implemented by northeastern and mid-Atlantic Tribal Nations and provides general adaptation principles to guide SLR response for Indigenous water and climate justice.

5.1. Witness warnings from human and non-human relations and follow the patterns of the natural world

Elizabeth James-Perry (2017) underscores a critical aspect of SLR response for her Tribal Nation, the Aquinnah Wampanoag, noting that Indigenous knowledge is about ‘careful, respectful observation and cooperation with natural systems for a sustainable future’. Determination of adaptation measures should be informed by witnessing and observing the natural world. Furthermore, eastern coastal Tribal Nations developing solutions to water insecurity resulting from SLR should integrate the ‘Witness’ principle when implementing future adaptation measures. For example, whales are species of great cultural significance for many northeast and mid-Atlantic Tribal Nations and patterns of whale beaching, sightings, and deaths including unusual mortality events are key

climatic change indicators for Indigenous Peoples in the region that relate to SLR and ecosystem health. Since January 2016, unusual mortality events, die-offs of whale populations, have occurred along the Atlantic coast (Brown et al., 2019; NOAA, 2020). These events and other changes in patterns of the natural world including devastation of plant and fish beings inform Indigenous responses and adaptation measures. Coastal Indigenous knowledge prioritizes interconnected balance among all living entities. Therefore, SLR adaptation measures to alleviate water security issues should witness the impacts and changes not just to humans but also include non-human relations.

5.2. Acknowledge traditional teachings and restore cultural stewardship practices

SLR Adaptation frameworks for eastern coastal Tribal Nations need to incorporate traditional ecological knowledge, cultural stewardship practices, as well as Indigenous tools and infrastructure innovations to address water security challenges. In 2012, Mashpee Wampanoag elder, Ramona Peters, and other Mashpee Wampanoag environmental leaders founded the Native Land Conservancy (NLC), the first Indigenous-led conservation organization in the eastern United States. NLC champions traditional knowledge and stewardship practices to restore Indigenous territories and address SLR (Zuckoff, 2019). Many of the northeast and mid-Atlantic Tribal Nations have traditional ecological knowledge on SLR as their communities previously lived or occupied areas now covered by water. Those teachings and practices should be prioritized for adaptation to SLR and can be combined if deemed appropriate with other scientific measures for blended knowledge mobilization for water security in coastal areas. For example, the Wampanoag Tribe of Gay Head (Aquinnah) where one third of homes rely on private wells as their source for drinking water developed their own Wampanoag Environmental Laboratory to provide regular water testing to their community (Wampanoag Tribe, 2020). A critical adaptive capacity building initiative to address emerging threats of climate change and SLR to water systems that restores tribal stewardship and responsibility for water. In this way, it is important for adaptation response efforts to include traditional knowledge holders in the development and implementation of SLR adaptation plans created by Tribal Nations for water security.

5.3. Mend the shoreline and practice healing for coastal and environmental sovereignty

The Shinnecock Nation prioritized Indigenous knowledge to address shoreline erosion in their territory (a peninsula that sits on Shinnecock Bay) and provide nature-based solutions for healing in coastal areas of their territory (Sengupta & Lawal, 2020). Coastal Indigenous knowledge of the region recognizes the trauma that humans have inflicted on the environment for centuries with the advent of colonization. Contemporary adaptation measures of many northeast and mid-Atlantic Tribal Nations work to mend the shoreline and coastal areas through cultural and ceremonial practices that promote healing and ecosystem rehabilitation. The

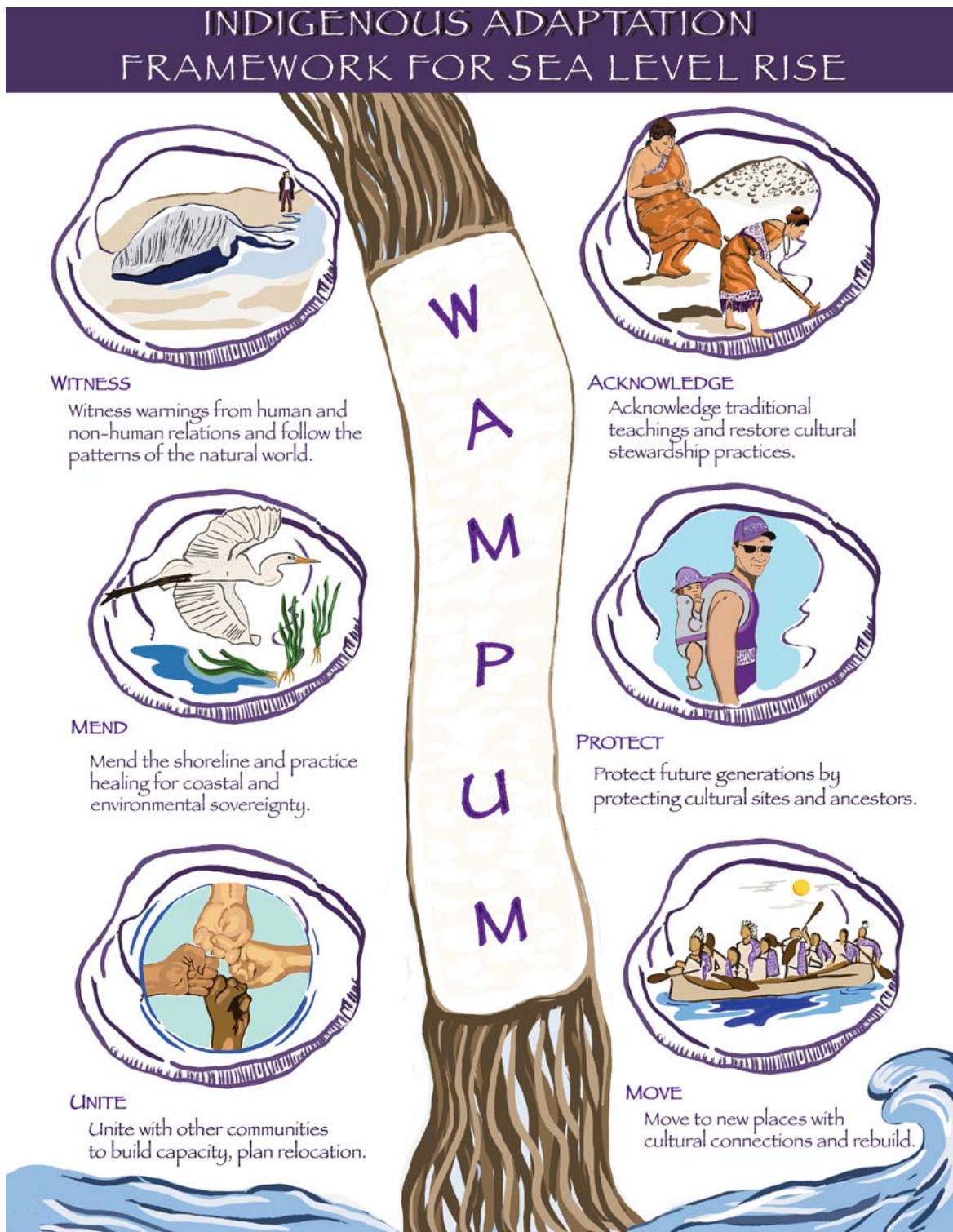


Figure 2. WAMPUM: Indigenous adaptation framework for sea level rise. Framework for adaptation to sea level rise (SLR) informed by Northeastern and Mid-Atlantic coastal Indigenous knowledge systems. The ‘WAMPUM’ adaptation framework includes the following SLR response strategies of witness, acknowledge, mend, protect, unite, and move.

Shinnecock Nation utilized their unique understanding of the coastal area grounded within their Indigenous teachings and language to design a coastal habitat restoration programme. Shinnecock means people of the stoney shore, but coastal erosion, storm surge, and flooding events had erased many of those historic stone formations from the shoreline. In response to increasing SLR risks such as flooding and erosion and to

protect Tribal infrastructure including water supplies the Shinnecock Nation replenished their beaches with nature-based solutions and added boulders along their shores to diminish storm surge and tidal wave impacts. The Shinnecock Nation also utilized oysters and eel grass to help fortify the shore and improve water quality. Ultimately, the Shinnecock SLR adaptation measures highlight the importance of mending

coastal areas and leading through healing and nature-based solutions for Indigenous SLR responses in contrast to western adaptation frameworks that rely solely on ‘hard’ infrastructure solutions.

5.4. Protect future generations by protecting cultural sites and ancestors

Eastern coastal Tribal Nations have a long history of coastal management related to SLR. Many ancient village sites and fishing areas are now submerged as sea levels rose in past millennia. One northeastern Tribal Nation, the Narragansett Tribe, is leading scientific innovation for underwater archaeology in collaboration with non-Indigenous scientists (Knapschaefer, 2015). SLR will continue to inundate cultural sites, but the investment in new technology and adaptive capacity of the Narragansett will protect submerged cultural resources for future generations. Adaptation measures that consider inundation of cultural sites are pivotal to Indigenous ways of knowing; however, existing adaptation frameworks do not consider SLR impacts to cultural resources. Furthermore, existing frameworks do not associate any linkages between water security and cultural site protection. Conversely, Indigenous water security is inclusive of cultural resources and works to ensure an adequate water quantity and quality for cultural and ceremonial activities including the protection of sacred sites that encompass a variety of waterscapes. The Pamunkey Tribe utilized traditional ecological knowledge to build a living shoreline along the reservation coast and Pamunkey River to reduce SLR impacts on cultural resources including a tribal museum, historic buildings, and residential areas (Milligan et al., 2019). Studies have shown that cultural sites (archaeological, ceremonial, historical, museums, archives, etc.) across U.S. coastal regions are likely to be inundated by SLR (Carmichael et al., 2018; Reeder-Myers, 2015). Northeastern and mid-Atlantic Tribal Nations, such as the Penobscot Nation and Shinnecock Nation, are also working to protect their ancestors as burial sites and petroglyphs face SLR inundation and erosion (Seacoast Online, 2018; Sengupta & Lawal, 2020). The protection of cultural sites is an integral principle of Indigenous SLR adaptation not only because it advances Indigenous water justice but ensures the preservation of eastern Tribal Nation history, culture, and ceremonial practices for future generations.

5.5. Unite with other communities to build capacity, plan relocation

Northeastern and mid-Atlantic Tribal Nations with support from United South and Eastern Tribes, Inc. (USET) and the Tribal climate science liaison in partnership with the Northeast Climate Adaptation Science Center are actively working to build Tribal capacity for climate change adaptation through the development of climate change and hazard mitigation plans. Intertribal organizations, such as USET, provide collaborative forums and educational opportunities for environmental leaders and managers from eastern Tribal Nations to gather and build both individual Tribal and collective capacity (USET, 2020a). Restoration of Tribal sovereignty and territorial

integrity has been of increasing concern for Wabanaki Tribal Nations (Aroostook Band of Micmac, Houlton Band of Maliseet, Passamaquoddy Tribe, and Penobscot Nation) and the Mashpee Wampanoag respectively all of whom have faced duplicitous political threats to diminish their rights as Tribal Nations by state and federal governments in recent years. However, as Daigle et al. (2019) highlight Indigenous ways of knowing, especially storytelling, provide distinct tools for ‘adaptive resilience’ among eastern Indigenous Peoples facing SLR challenges. Adaptive resilience building is mobilized when Indigenous and non-Indigenous scientists and community members unite for planning around SLR (Daigle et al., 2019). Among northeastern and mid-Atlantic Tribal Nations there is a common philosophy – ‘We Move Together’ – this practice of collective action is captured by different Indigenous languages such as the Shinnecock who say ‘Mamoweenene’ and the Passamaquoddy who say, ‘Menakatuluhkatomon’. The phrase underscores ‘the relational aspects of tribal culture to the social ecological networks within the environment. It also describes the collective nature of decision making or “kinship ties” through clan networks as it relates to living within these social ecological areas’ (Daigle et al., 2019, p. 783). Traditional kinship networks can be reconstituted to dismantle past colonial disenfranchisement as eastern Tribal Nations work collaboratively to unite their communities to address SLR, climate change and water injustices.

5.6. Move to new places with cultural connections and rebuild

Historically, eastern coastal Tribal Nations had numerous village sites and larger territorial areas that allowed communities to adapt to climatic changes and move when necessary often inhabiting certain areas on a seasonal basis. However, contemporary population densities and colonial policies have stolen Indigenous lands along the eastern Atlantic coast making land availability and affordability for Tribal Nations to retreat or relocate to nearly impossible without financial resources and or U.S. federal government intervention. Many northeastern and mid-Atlantic Tribal Nations are already facing SLR risks including but not limited to coastal erosion, sea level rise, subsidence, storm surges, inadequate space for population growth, saltwater intrusion, flooding, hurricanes, etc. In recent years, the Passamaquoddy Tribe at their Pleasant Point/Sipayik reservation faced increasing shoreline erosion impacting water infrastructure including a wastewater treatment plant (EPA, 2019). Adaptation measures were leveraged based on existing capacities but continued projections of SLR acceleration will only further inundate Tribal Nation lands in eastern coastal areas. Federal legislation is needed along with funding allocations that support Tribal Nation relocation to areas along the eastern Atlantic coast that preserve cultural connections and stewardship practices for ancestral homelands.

6. Conclusions

The WAMPUM adaptation framework provides a path forward for Indigenous water security in response to SLR.

Moreover, the framework is a model and call to action for scientists, researchers, and Indigenous nations to reject oppressive and colonial adaptation frameworks and develop their own decolonial Indigenous frameworks that capture Indigenous knowledge systems for resilience in the face of climate change. The six SLR adaptation principles (Witness, Acknowledge, Mend, Protect, Unite, and Move) proposed in this article embrace Indigenous knowledge and resiliency among eastern coastal Tribal Nations for water protection. More studies are needed that are Indigenous led and co-developed with Tribal Nations in the regions to not only test the proposed adaptation framework but explore additional climate change impacts on Tribal Nations in eastern Atlantic coastal regions.

Acknowledgements

I would like to extend my deepest gratitude to the anonymous reviewers for their constructive and generous feedback throughout the review process. Tabutne (Thank you) to Courtney Leonard and Frank Buffalo Hyde for your feedback and graphic design support.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributor

Dr. Kelsey Leonard is a citizen of Shinnecock Indian Nation. Dr. Leonard is an Assistant Professor in the Faculty of Environment at the University of Waterloo, Ontario, Canada.

ORCID

Kelsey Leonard  <http://orcid.org/0000-0002-7531-128X>

References

- Arkema, K. K., Griffin, R., Maldonado, S., Silver, J., Suckale, J., & Guerry, A. D. (2017). Linking social, ecological, and physical science to advance natural and nature-based protection for coastal communities. *Annals of the New York Academy of Sciences*, 1399(1), 5–26. <https://doi.org/10.1111/nyas.13322>
- Beckman, J. N., & Garcia, J. E. (2019). Rates of relative sea level rise along the United States East Coast. *Virginia Journal of Science*, 70(1), 3. <https://doi.org/10.25776/yfjr-av28>
- Belfer, E., Ford, J. D., & Maillet, M. (2017). Representation of Indigenous peoples in climate change reporting. *Climatic Change*, 145(1-2), 57–70. <https://doi.org/10.1007/s10584-017-2076-z>
- BIA. (2020). Bureau of Indian affairs Tribal resilience program. U.S. Department of the Interior. Retrieved August 30, 2020, from <https://www.bia.gov/bia/ots/tribal-resilience-program>
- Bridges, T., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z. A., Fischenich, C. J., Gailani, J. Z., Leuck, L. D., Piercy, C. D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., & Wamsley, T. V. (2015). Use of natural and nature-based features (NNBF) for coastal resilience, North Atlantic coast comprehensive study: Resilient adaptation to increasing risk. US Army Corps of Engineers: Engineer Research and Development Center, Vicksburg, MS.
- Brown, D. M., Sieswerda, P. L., & Parsons, E. C. M. (2019). Potential encounters between humpback whales (*Megaptera novaeangliae*) and vessels in the New York Bight apex, USA. *Marine Policy*, 106, 103527. <https://doi.org/10.1016/j.marpol.2019.103527>
- Cameron, E. S. (2012). Securing Indigenous politics: A critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. *Global Environmental Change*, 22(1), 103–114. <https://doi.org/10.1016/j.gloenvcha.2011.11.004>
- Carmichael, B., Wilson, G., Namarnyilk, I., Nadji, S., Brockwell, S., Webb, B., Hunter, F., & Bird, D. (2018). Local and Indigenous management of climate change risks to archaeological sites. *Mitigation and Adaptation Strategies for Global Change*, 23(2), 231–255. <https://doi.org/10.1007/s11027-016-9734-8>
- Church, J. A., Clark, P. U., Cazenave, A., Gregory, J. M., Jevrejeva, S., Levermann, A., Merrifield, M. A., Milne, G. A., Nerem, R. S., Nunn, P. D., Payne, A. J., Pfeffer, W. T., Stammer, D., & Unnikrishnan, A. S. (2013). Sea level change. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. M. Midgley (Eds.), *Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change*. Cambridge University Press.
- Cozzetto, K., Chief, K., Dittmer, K., Brubaker, M., Gough, R., Souza, K., Ettawageshik, F., Wotkins, S., Opitz-Stapleton, S., Duren, S., & Chavan, P. (2013). Climate change impacts on the water resources of American Indians and Alaska Natives in the U.S. In J. K. Maldonado, B. Colombi, & R. Pandya (Eds.), *Climate change and indigenous peoples in the United States* (pp. 61–76). Springer. https://doi.org/10.1007/978-3-319-05266-3_6
- Daigle, J. J., Michelle, N., Ranco, D. J., & Emery, M. R. (2019). Traditional lifeways and storytelling: Tools for adaptation and resilience to ecosystem change. *Human Ecology*, 47(5), 777–784. <https://doi.org/10.1007/s10745-019-00113-8>
- Dangendorf, S., Hay, C., Calafat, F. M., Marcos, M., Piecuch, C. G., Berk, K., & Jensen, J. (2019). Persistent acceleration in global sea-level rise since the 1960s. *Nature Climate Change*, 9(9), 705–710. <https://doi.org/10.1038/s41558-019-0531-8>
- Doberstein, B., Tadgell, A., & Rutledge, A. (2020). Managed retreat for climate change adaptation in coastal megacities: A comparison of policy and practice in Manila and Vancouver. *Journal of Environmental Management*, 253, 109753. <https://doi.org/10.1016/j.jenvman.2019.109753>
- EPA. (2014). EPA region 2 climate change adaptation implementation plan. <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100LEWF.PDF?Dockey=P100LEWF.PDF>
- EPA. (2019). Federal agencies come together to address sea level rise threat to infrastructure. In *Resilience and adaptation new England (RAINE)*. https://geopub.epa.gov/RAINE/PDF/Passamaquoddy_WWTP_82616.pdf
- EPA. (2020, June 30). Tribes approved for treatment as a state (TAS). Retrieved August 30, 2020, from <https://www.epa.gov/tribal/tribes-approved-treatment-state-tas>
- Epanchin-Niell, R., Kousky, C., Thompson, A., & Walls, M. (2017). Threatened protection: Sea level rise and coastal protected lands of the eastern United States. *Ocean & Coastal Management*, 137, 118–130. <https://doi.org/10.1016/j.ocecoaman.2016.12.014>
- Fu, X. (2020). Measuring local sea-level rise adaptation and adaptive capacity: A national survey in the United States. *Cities*, 102, 102717. <https://doi.org/10.1016/j.cities.2020.102717>
- Gibbs, M. T. (2016). Why is coastal retreat so hard to implement? Understanding the political risk of coastal adaptation pathways. *Ocean & Coastal Management*, 130, 107–114. <https://doi.org/10.1016/j.ocecoaman.2016.06.002>
- Gornitz, V., Oppenheimer, M., Kopp, R., Horton, R., Orton, P., Rosenzweig, C., Solecki, W., & Patrick, L. (2020). Enhancing New York City's resilience to sea level rise and increased coastal flooding. *Urban Climate*, 33, 100654. <https://doi.org/10.1016/j.uclim.2020.100654>
- Hardy, R. D., Milligan, R. A., & Heynen, N. (2017). Racial coastal formation: The environmental injustice of colorblind adaptation planning for sea-level rise. *Geoforum; Journal of Physical, Human, and Regional Geosciences*, 87, 62–72. <https://doi.org/10.1016/j.geoforum.2017.10.005>
- Hauer, M. E. (2017). Migration induced by sea-level rise could reshape the US population landscape. *Nature Climate Change*, 7(5), 321–325. <https://doi.org/10.1038/nclimate3271>

- IPCC. (2012). Summary for policymakers. In C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, P. M. Midgley (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation: A special report of working groups I and II of the intergovernmental panel on climate change* (pp. 3–21). Cambridge University Press.
- James-Perry, E. (2017, December). Respecting the sea: A conversation with Elizabeth James-Perry. *Cultural Survival*. <https://www.culturalsurvival.org/publications/cultural-survival-quarterly/respecting-sea-conversation-elizabeth-james-perry>
- Jantarasami, L. C., Novak, R., Delgado, R., Marino, E., McNeeley, S., Narducci, C., Raymond-Yakoubian, J., Singletary, L., & Powys Whyte, K. (2018). Tribes and Indigenous peoples. In D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, & B. C. Stewart (Eds.), *Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II* (pp. 572–603). U.S. Global Change Research Program. <https://doi.org/10.7930/NCA4.2018.CH15>
- Jurjonas, M., & Seekamp, E. (2018). Rural coastal community resilience: Assessing a framework in eastern North Carolina. *Ocean & Coastal Management*, 162, 137–150. <https://doi.org/10.1016/j.ocecoaman.2017.10.010>
- Jurjonas, M., & Seekamp, E. (2020). 'A commons before the sea': Climate justice considerations for coastal zone management. *Climate and Development*, 12(3), 199–203. <https://doi.org/10.1080/17565529.2019.1611533>
- Jurjonas, M., Seekamp, E., Rivers III, L., & Cutts, B. (2020). Uncovering climate (in)justice with an adaptive capacity assessment: A multiple case study in rural coastal North Carolina. *Land Use Policy*, 94, 104547. <https://doi.org/10.1016/j.landusepol.2020.104547>
- Klein, R. J. T., Nicholls, R. J., Ragoonaden, S., Capobianco, M., Aston, J., & Buckley, E. N. (2001). Technological options for adaptation to climate change in coastal zones. *Journal of Coastal Research*, 17(3), 531–543.
- Knapschaefer, J. (2015, December 2). Villages beneath the sea. Quadangles online. <https://web.uri.edu/quadangles/villages-beneath-the-sea/>
- Kopp, R. E. (2013). Does the mid-Atlantic United States sea level acceleration hot spot reflect ocean dynamic variability? *Geophysical Research Letters*, 40(15), 3981–3985. <https://doi.org/10.1002/grl.50781>
- Maldonado, J. K., Colombi, B., & Pandya, R. (2016). *Climate change and Indigenous peoples in the United States*. Springer International Pu.
- Maldonado, J. K., Shearer, C., Bronen, R., Peterson, K., & Lazrus, H. (2013). The impact of climate change on tribal communities in the US: Displacement, relocation, and human rights. In J. K. Maldonado, B. Colombi, & R. Pandya (Eds.), *Climate change and indigenous peoples in the United States* (pp. 93–106). Springer. <https://doi.org/10.1007/s10584-013-0746-z>
- Marino, E. (2018). Adaptation privilege and voluntary buyouts: Perspectives on ethnocentrism in sea level rise relocation and retreat policies in the US. *Global Environmental Change*, 49, 10–13. <https://doi.org/10.1016/j.gloenvcha.2018.01.002>
- Marsooli, R., Lin, N., Emanuel, K., & Feng, K. (2019). Climate change exacerbates hurricane flood hazards along US Atlantic and Gulf Coasts in spatially varying patterns. *Nature Communications*, 10(1), 1–9. <https://doi.org/10.1038/s41467-019-11755-z>
- McGregor, D., Whitaker, S., & Sritharan, M. (2020). Indigenous environmental justice and sustainability. *Current Opinion in Environmental Sustainability*, 43, 35–40. <https://doi.org/10.1016/j.cosust.2020.01.007>
- McNeeley, S. M. (2017). Sustainable climate change adaptation in Indian country. *Weather, Climate, and Society*, 9(3), 393–404. <https://doi.org/10.1175/WCAS-D-16-0121.1>
- Milligan, D. A., Hardaway Jr, C. S., & Wilcox, C. A. (2019). Pamunkey Indian reservation shoreline management plan.
- Moser, S. C., Kasperson, R. E., Yohe, G., & Agyeman, J. (2008). Adaptation to climate change in the northeast United States: Opportunities, processes, constraints. *Mitigation and Adaptation Strategies for Global Change*, 13(5–6), 643–659. <https://doi.org/10.1007/s11027-007-9132-3>
- Nash, C. L., & Wholey, H. A. (2018). Prioritising heritage resources in a time of loss: Sea level rise and archaeological resources of the middle Atlantic region, US. *Conservation and Management of Archaeological Sites*, 20(4), 285–295. <https://doi.org/10.1080/13505033.2018.1558392>
- National Oceanic and Atmospheric Administration (NOAA). (2010). *Adapting to climate change: A planning guide for state coastal managers*. NOAA Office of Ocean and Coastal Resource Management. <http://coastalmanagement.noaa.gov/climate/adaptation.html>
- National Oceanic and Atmospheric Administration (NOAA). (2020, September 8). 2016–2020 Humpback whale unusual mortality event along the Atlantic Coast. Retrieved August 30, 2020, from <https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2020-humpback-whale-unusual-mortality-event-along-atlantic-coast>
- Neumann, B., Vafeidis, A. T., Zimmermann, J., Nicholls, R. J., & Kumar, L. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding – A global assessment. *PLoS One*, 10(3), e0118571. <https://doi.org/10.1371/journal.pone.0118571>
- Nicholls, R. J. (2018). Adapting to sea-level rise. In Z. Zommers, & K. Alverson (Eds.), *Resilience* (pp. 13–29). Elsevier. <https://doi.org/10.1016/B978-0-12-811891-7.00002-5>
- Norris, T., Vines, P. L., & Hoeffel, E. M. (2012). *The American Indian and Alaska native population: 2010*. US Department of Commerce, Economics and Statistics Administration, US Census Bureau.
- Norton-Smith, K., Lynn, K., Chief, K., Cozzetto, K., Donatuto, J., Redsteer, M. H., Kruger, L. E., Maldonado, J., Viles, C., & Whyte, K. P. (2016). *Climate change and indigenous peoples: A synthesis of current impacts and experiences*. Gen. Tech. Rep. PNW-GTR-944. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 136 p. 944.
- OECD. (2019). *Responding to rising seas: OECD country approaches to tackling coastal risks*. OECD Publishing. <https://doi.org/10.1787/9789264312487-en>
- Oppenheimer, M., Glavovic, B. C., Hinkel, J., van de Wal, R., Magnan, A. K., Abd-Elgawad, A., Cai, R., CifuentesJara, M., DeConto, R. M., Ghosh, T., Hay, J., Isla, F., Marzeion, B., Meysignac, B., & Sebesvari, Z. (2019). Sea level rise and implications for low-lying Islands, coasts and communities. In H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegria, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC special report on the ocean and cryosphere in a changing climate*. In press.
- Ransom, J. W., & Ettenger, K. T. (2001). 'Polishing the Kaswentha': A Haudenosaunee view of environmental cooperation. *Environmental Science & Policy*, 4(4–5), 219–228. [https://doi.org/10.1016/S1462-9011\(01\)00027-2](https://doi.org/10.1016/S1462-9011(01)00027-2)
- Ravichandran, M. (2015). Identification of environmental health gaps in state-recognized American Indian tribes in Connecticut.
- Redsteer, M. H., Bemis, K., Chief, K., Gautam, M., Middleton, B. R., Tsosie, R., & Ferguson, D. B. (2013). Unique challenges facing southwestern tribes. In G. Garfin, A. Jardine, R. Merideth, M. Black, & S. LeRoy (Eds.), *Assessment of climate change in the Southwest United States* (pp. 385–404). Island Press. https://doi.org/10.5822/978-1-61091-484-0_17
- Reeder-Myers, L. A. (2015). Cultural heritage at risk in the twenty-first century: A vulnerability assessment of coastal archaeological sites in the United States. *The Journal of Island and Coastal Archaeology*, 10(3), 436–445. <https://doi.org/10.1080/15564894.2015.1008074>
- Reo, N. J., Whyte, K., Ranco, D., Brandt, J., Blackmer, E., & Elliott, B. (2017). Invasive species, Indigenous Stewards, and vulnerability discourse. *American Indian Quarterly*, 41(3), 201–223. <https://doi.org/10.5250/amerindiquar.41.3.0201>
- Robison, J., Cosens, B., Jackson, S., Leonard, K., & McCool, D. (2018). Indigenous water justice. *Lewis & Clark Law Review*, 22, 841.
- Sanchez, G. M., Terando, A., Smith, J. W., Garcia, A. M., Wagner, C. R., & Meentemeyer, R. K. (2020). Forecasting water demand across a rapidly urbanizing region. *Science of the Total Environment*, 730, 139050. <https://doi.org/10.1016/j.scitotenv.2020.139050>
- Seacoast Online. (2018, September 12). *Tribal historian: Rising sea levels threaten ancient artifacts and burial sites*. Retrieved August 30, 2020,

- from <https://bangordailynews.com/2018/09/12/news/bangor/tribal-historian-rising-sea-levels-threaten-ancient-artifacts-and-burial-sites/>
Sengupta, S., & Lawal, S. (2020, March 5). The original long Islanders fight to save their land from a rising sea. *New York Times*. <https://www.nytimes.com/2020/03/05/climate/shinnecock-long-island-climate.html>
- Siders, A. R., & Keenan, J. M. (2020). Variables shaping coastal adaptation decisions to armor, nourish, and retreat in North Carolina. *Ocean & Coastal Management*, 183, 105023. <https://doi.org/10.1016/j.ocecoaman.2019.105023>
- Sweet, W. W. V., Kopp, R., Weaver, C. P., Obeysekera, J. T. B., Horton, R. M., Thieler, E. R., & Zervas, C. E. (2017). Global and regional sea level rise scenarios for the United States (noaa:18399). <https://repository.library.noaa.gov/view/noaa/18399>
- Taylor, L., Curson, D., Verutes, G. M., & Wilsey, C. (2020). Mapping sea level rise impacts to identify climate change adaptation opportunities in the Chesapeake and Delaware Bays, USA. *Wetlands Ecology and Management*, 28, 527–541. <https://doi.org/10.1007/s11273-020-09729-w>
- Tol, R. S. J., Klein, R. J. T., & Nicholls, R. J. (2008). Towards successful adaptation to sea-level rise along Europe's coasts. *Journal of Coastal Research*, 24(2), 432–442. <https://doi.org/10.2112/07A-0016.1>
- USET. (2020a). Climate change. United South & Eastern Tribes. <https://www.usetinc.org/climate-change-headlines/>
- USET. (2020b). History of USET. Retrieved August 30, 2020, from <https://www.usetinc.org/about-uset/history/>
- USGS. (2020). Hydrologic assessment of the shallow groundwater-flow system beneath the Shinnecock Nation Tribal Lands, Suffolk County, New York. Retrieved August 30, 2020, from <https://www.usgs.gov/centers/ny-water/science/hydrologic-assessment-shallow-groundwater-flow-system-beneath-shinnecock>
- van der Nat, A., Vellinga, P., Leemans, R., & van Slobbe, E. (2016). Ranking coastal flood protection designs from engineered to nature-based. *Ecological Engineering*, 87, 80–90. <https://doi.org/10.1016/j.ecoleng.2015.11.007>
- Wampanoag Tribe. (2020). Water testing. Retrieved August 30, 2020, from <https://wampanoagtribe-nsn.gov/water-testing>
- Whyte, K. P. (2016). Is it colonial déjà vu? Indigenous peoples and climate injustice. In J. Adamson, & M. Davis (Eds.), *Humanities for the environment* (pp. 102–119). Routledge.
- Whyte, K. P. (2017). Our ancestors' dystopia now. In U. K. Heise, J. Christensen, & M. Niemann (Eds.), *The Routledge companion to the environmental humanities* (pp. 1–10). Routledge.
- Whyte, K. P., Brewer, J. P., & Johnson, J. T. (2016). Weaving Indigenous science, protocols and sustainability science. *Sustainability Science*, 11(1), 25–32. <https://doi.org/10.1007/s11625-015-0296-6>
- Wildcat, D. R. (2013). Introduction: Climate change and indigenous peoples of the USA. In J. K. Maldonado, B. Colombi, & R. Pandya (Eds.), *Climate change and Indigenous peoples in the United States* (pp. 1–7). Springer. https://doi.org/10.1007/978-3-319-05266-3_1
- Wong, P. P., Losada, I. J., Gattuso, J.-P., Hinkel, J., Khattabi, A., McInnes, K. L., Saito, Y., & Sallenger, A. (2014). Coastal systems and low-lying areas. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 361–409). Cambridge University Press.
- Woodruff, J. D., Irish, J. L., & Camargo, S. J. (2013). Coastal flooding by tropical cyclones and sea-level rise. *Nature*, 504(7478), 44–52.
- Xie, D., Zou, Q.-P., Mignone, A., & MacRae, J. D. (2019). Coastal flooding from wave overtopping and sea level rise adaptation in the northeastern USA. *Coastal Engineering*, 150, 39–58. <https://doi.org/10.1016/j.coastaleng.2019.02.001>
- Yin, J., Schlesinger, M. E., & Stouffer, R. J. (2009). Model projections of rapid sea-level rise on the northeast coast of the United States. *Nature Geoscience*, 2(4), 262–266. <https://doi.org/10.1038/ngeo462>
- Zuckoff, E. (2019, November 18). Native land conservancy tackles climate change from Indigenous perspective. *Cape and Islands*. Retrieved August 30, 2020, from <https://www.capeandislands.org/post/native-land-conservancy-tackles-climate-change-indigenous-perspective>