



From assembly to action: how planning language guides execution in indigenous climate adaptation

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Abstract

Indigenous Peoples of the USA are already feeling the disproportionate impacts of climate change and the challenges created to their resource-based livelihoods from effects like sea level rise, species migration and extinction, and more severe and frequent storms. In response, American Indigenous communities have initiated hundreds of adaptation actions. At the center of the Indigenous climate response are efforts to identify local climate threats and prioritize adaptation actions through careful planning. To better understand their potential, 14 tribal climate adaptation plans were reviewed to decipher different types of proposed adaptation actions and evaluated based on 11 criteria often associated with successful plan implementation. Adaptation actions were dominated by “soft” measures such as capacity building with neighboring jurisdictions, policy reform, and information gathering. The most common criteria present in the tribal plans were identification of a party to implement an action and mainstreaming of climate activities into other documents, such as resource management plans. In-depth interviews with tribal climate specialists found that actual implementation has been slowed by funding shortages, lack of staff expertise, and weak communication and coordination across tribal government departments. Successful implementation has occurred through the mainstreaming of adaptation priorities into other environmental concerns, such as hazard mitigation or emergency preparedness, that benefit from more stable funding. Training staff, developing dedicated funding streams, and the integration of adaptation efforts into all areas of tribal government operations is needed to ensure Indigenous communities can protect vital cultural resources and steward lands under rapidly changing climatic conditions.

Keywords Climate change · Adaptation · Planning · Indigenous

1 Introduction

Indigenous communities throughout the USA, from the Arctic tundra to the wetlands of the Gulf Coast, are already feeling the powerful effects of climate change, like sea level rise, habitat destruction, species migration, warming temperatures, and more severe and

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frequent storms (Jantarasami et al. 2018). According to the Intergovernmental Panel on Climate Change (IPCC), the world is 1.1 °C warmer on average compared to pre-industrial temperatures and could double by 2050 without deep reductions in greenhouse gas emissions (IPCC, 2021). In 2018, the IPCC reported dire consequences if global average temperatures hit a threshold of 2 °C, including the geographical range for all species could be halved, permafrost could thaw, 99% of the world's coral reefs could die, and the global annual catch of fish could shrink by three million tons (IPCC, 2018). In Alaska, where a large portion of American Indigenous communities reside, warming is taking place at a rate two to three times higher than the global average rise (Jay et al. 2018).

Because of the unique resource-based economic, social, and cultural livelihoods of many Indigenous communities, adaptation will be essential to managing local vulnerabilities exacerbated by climate change (Wildcat, 2013). To help ease the burden of climate risks, the United Nations estimated in 2016 that \$140–\$300 billion would need to be invested annually in adaptation strategies globally from 2010 to 2030 and \$280 to \$500 billion each year from 2030 to 2050 (Puig et al. 2016). Given the massive investment required and the wide variety of response mechanisms available, communities are adopting planning techniques that permit adaptation strategies to be assessed based on factors like suitability, cost, and effectiveness (Füssel, 2007). A growing body of literature points to adaptation planning as a useful exercise in both advancing community goals and reducing disaster costs (Woodruff and Regan, 2019). For America's most vulnerable communities, adaptation planning could help distribute scarce resources and prioritize climate response.

Adaptation planning is part of a larger continuum of activities intended to identify climate risks and threats, develop a response, oversee and manage the response, and utilize feedback to reassess and improve overall climate response (Bierbaum et al. 2013). Government efforts at climate adaptation often begin through a vulnerability assessment that explains climate threats and identifies the most at-risk elements of the community, including species, ecosystems, cultural resources, and infrastructure. Planning response options come next and are followed by the implementation, monitoring, and evaluation of the selected strategies. Finally, the adaptation strategies are reviewed, revised, and the process is begun again or amended to improve effectiveness of the response. Despite climate threats that could strip billions in future earnings and constrain the pursuit of enterprise and well-being (Jay et al. 2018), few U.S. cities have moved beyond initial vulnerability assessments or planning activities (Hughes, 2015).

According to the Fourth National Climate Assessment, American Indian and Alaska Native communities have initiated numerous climate adaptation and mitigation activities in the past decade, like emerald ash borer (*Agrilus planipennis*) mapping by the Wabanaki in Maine or the Inupiat of Alaska observing wind and wave patterns to coastal erosion and flooding (Jantarasami et al. 2018). However, the body of literature around the Indigenous climate response provides few clues as to the barriers, successes, and overall effectiveness of planning and adaptation activities in tribal communities. Preston et al. (2011) note that evaluation and monitoring of adaptation planning can reduce societal and ecological vulnerability, improve accountability through evidence-based policy, and expand learning opportunities for adaptive management. This paper addresses the need expressed by Baker et al. (2012) for more formal evaluation of climate plan implementation by assessing planning activities and actions within the context of Indigenous communities in the USA. Criteria were adapted from existing plan analyses in the literature and applied through a comprehensive text analysis of the implementation language and methods included in tribal climate adaptation plans, such as cost projections, timelines for action, and mainstreaming, a strategy that incorporates climate adaptation actions into other planning activities. Plans

were also evaluated based on adaptation typologies developed by Biagini et al. (2014) to better understand how implementation varies between inexpensive, participatory “soft” adaptation strategies and engineered “hard” infrastructure adaptation strategies. Further, in-depth interviews with tribal climate specialists were conducted to detail missteps and successes in the implementation of the plans, as well as recommendations for improving implementation language in future tribal climate planning efforts.

2 Data

Data for the text analysis come from publicly available tribal climate adaptation plans. The University of Oregon’s Tribal Climate Change Guide and Northern Arizona University’s Tribes & Climate Change portal provide clearinghouses for dozens of tribal climate documents, including vulnerability assessments, adaptation plans, and impact studies. The plans were developed in conjunction with private consultants, local universities and governments, federal agencies, and non-profits, or strictly through the tribal community’s own efforts. For the study, adaptation plans were selected due to the presence of goals, strategies, and recommendations for actions needed for analysis. Other planning documents, such as vulnerability assessments, often omit these strategies and are less helpful to an analysis focused on implementation.

In total, 14 tribal adaptation plans were chosen for text analysis out of 27 available in the two databases in June 2020. Thirteen plans were excluded because they lacked readily identifiable goals and recommendations needed for the analysis. Figure 1 shows the distribution of the Indigenous adaptation plans on a map of the United States. The communities span both coasts and the Great Lakes, 5 time zones, and 10 different states. The plans represent individual tribal communities, like the Nez Perce or Yakama, and cooperative efforts



Fig. 1 Map showing the distribution of tribal communities represented in the study

from two regional associations, the Norton Bay Watershed Council and the Intertribal Council of Michigan. Table 1 provides basic demographic characteristics for the community plans not represented by regional organizations. The smallest reservation served by these planning documents is the Annette Island Reserve of the Metlakatla Indian Community with a population of only 1635 people, while the Navajo Nation represents the largest land-based tribe in the USA with a reservation population one hundred times larger than Metlakatla's reserve off the southeast coast of Alaska (U.S. Census Bureau, [n.d.](#)). Education levels and median household incomes also showed some variation, albeit not to the same degree as population. The communities represented in this plan analysis provide a diverse cultural, geographic, and climate-sensitive sample for analysis. The 14 plans delineate 556 proposed adaptation actions, strategies, objectives, and goals, with some of these proposed actions in various stages of implementation.

3 Methods

To assess the effectiveness of the language used in tribal climate adaptation plans, eleven criteria were developed from previous climate planning literature that best captured a strong likelihood of project implementation. Adaptation typologies were borrowed from Biagini et al. (2014) to analyze the ways in which tribes intend to fight climate change and maintain their communities. This use of plan evaluation methodology for text analysis allows for comparison between documents and improves the identification of strengths and weaknesses between the plans themselves (Woodruff and Stults, 2016). However, plan evaluation can only act as a predictor of implementation and cannot account for the outside forces influencing climate adaptation. For that, semi-structured interviews took place with four tribal climate plan managers.

3.1 Plan evaluation

Plan evaluation is a text analysis methodology that involves the establishment of assessment criteria, the application of that criteria to each document, and the examination of trends, inconsistencies, and overall results. Because of the small number of adaptation plans selected for review, manual analysis was used instead of relying on computer-assisted text mapping. Manual review of documents for the presence of key assessment criteria is preferable when classifying content for a few hundred documents or less (Kobayashi et al. 2018). The assessment criteria create a framework to best compare planning documents (Dupuis and Biesbroek, 2013). The majority of the evaluation criteria were derived from two seminal analyses of local climate adaptation plans: Berke and Goldschalk's (2009) large-scale meta-analysis of local land use plans and Woodruff and Stults' (2016) examination of dozens of local climate adaptation plans in the USA.

Berke and Goldschalk (2009) set out to develop basic concepts and criteria to better define plan quality. Their literature review netted dozens of studies evaluating hundreds of local and state plans and produced a list of internal and external characteristics of high-quality plans. The tribal climate plan evaluation includes many of Berke and Goldschalk's characteristics relevant to plan implementation and evaluation, such as action timelines, identified funding sources, and the naming of an individual, department, or organization responsible for implementation. More recently, Woodruff and Stults (2016) examined 44 local climate adaptation plans in the United States using 124 different evaluation criteria.

Table 1 Basic characteristics of the tribal communities (not represented in this table are the communities in the regional plans by the Norton Bay Watershed Council and the Inter-tribal Council of Michigan). * Data derived from My Tribal Area (U.S. Census Bureau, [n.d.](#));** Education level connotes a bachelor's degree or higher.

	Puyallup	Nez Perce	Yakama	St. Regis Mohawk	Metlakatla	Lummi	Red Lake	Navajo	Shinnecock	Swinomish	Chippewa Cree	Nome
<i>Plan year</i>	2016	2011	2016	2013	2017	2016	2014	2014	2013	2010	2018	2017
<i>Population*</i>	53026	19251	30654	3325	1654	5641	5815	172813	N/A	3022	3706	4026
<i>Education**</i>	29.3%	16.3%	8.8%	23.6%	10.4%	20.8%	6.8%	8.4%	N/A	39%	10.1%	24.6%
<i>Median household income*</i>	\$78,526	\$44,354	\$49,047	\$42,090	\$56,188	\$54,038	\$39,676	\$28,052	N/A	\$65,170	\$29,435	\$84,096

The Woodruff and Stults plan analysis included 16 criteria focused on implementation and monitoring that closely mirrored Berke and Goldschalk's (2009) earlier effort. The 11 tribal climate plan evaluation criteria summarized in Table 2 adapt the plan quality characteristics and standards utilized by Berke and Goldschalk and Woodruff and Stults and are corroborated by countless other scholars in the area of plan evaluation. These 11 criteria appeared most frequently in the literature, form a basis for comparison between tribal climate adaptation plans, and set a baseline for appraising the efficacy of planning activities.

3.1.1 Party ID (action)

The first implementation criterion identifies the party responsible for implementing an action. Eisenack and Stecker (2012) included an actor to lead and exercise climate response as a critical piece of any adaptation action framework. Similarly, Ford and King (2015) concluded that leadership was a main factor in providing direction and sustaining momentum in climate response. For the analysis of tribal climate adaptation plans, that actor could be a tribal official, government department, community organization, or other group.

3.1.2 Party ID (M and E)

The next criterion specifies a party responsible for monitoring and evaluating the progress and efficacy of an adaptation action. Two comprehensive analyses included this measure as part of their overall review (Berke and Goldschalk, 2009; Woodruff and Stults, 2016). Woodruff and Reagan (2019) argued that monitoring is a key activity in climate preparedness, and without it in place, communities could struggle to manage climate risk and effectively evaluate progress toward climate plan goals.

3.1.3 Measurable target

A measurable target is a quantifiable goal within the community's climate plan strategies. In their recent assessment framework for local climate plans, Olazabal et al. (2019) explained that targets let communities track progress, prioritize response, and establish protocols for securing climate funding. Preston et al. (2011) noted that targets allow for accountability in environmental policy assessment.

3.1.4 Measurable indicator

Coupled with targets are metrics that can be measured, assessed, and monitored over the life of the plan (Berke and Goldschalk, 2009; Ford and King, 2015; Lesnikowski et al. 2018; Magnan, 2016; Olazabal et al. 2017; Preston et al. 2011, Woodruff and Stults, 2016). Ford and King, (2015) noted that deciding on indicators was crucial to monitoring, recording, and evaluation of plan goals. Olazabal et al. (2017) added that indicators help track adaptation trends over time.

3.1.5 Timeline

A timeline specifies a schedule to measure and evaluate progress toward completion of plan goals.

Table 2 Implementation criteria with descriptions and sources

Criteria	Sources	Examination
<i>Party ID (action)</i>	Berke and Goldschalk (2009), Eisenack and Stecker (2012), Ford and King (2015), Olazabal et al. (2017), Olazabal et al. (2019), Preston et al. (2011), Tang et al. (2010), Woodruff and Stults (2016)	Identifies who is responsible for implementing an action. Can be a tribal official, government department, community organization, etc.
<i>Party ID (M&E)</i>	Berke and Goldschalk (2009), Woodruff and Stults (2016)	Identifies who is responsible for monitoring and evaluating an action.
<i>Measurable target</i>	Berke and Goldschalk (2009), Olazabal et al. (2017)	Includes a quantifiable goal.
<i>Measurable indicator</i>	Berke and Goldschalk (2009), Ford and King. (2015), Lesnikowski et al. (2018), Magnan (2016), Olazabal et al. (2017), Preston et al. (2011), Woodruff and Stults (2016)	Includes a quantifiable metric that can be measured, assessed, and monitored over the life of the plan.
<i>Timeline</i>	Berke and Goldschalk (2009), Olazabal et al. (2017), Olazabal et al. (2019), Woodruff and Stults (2016)	Delineates a schedule to measure and evaluate progress toward completion.
<i>Cost</i>	Berke and Goldschalk (2009), Olazabal et al. (2017), Preston et al. (2011), Woodruff and Stults (2016)	Includes an estimate or exact price for implementation of the action.
<i>Funding source</i>	Arundsen et al. (2010), Berke and Goldschalk (2009), Ford and King (2015), Hughes (2015), Olazabal et al. (2019), Tang et al. (2010), Woodruff and Stults (2016)	Identifies a source for funding its progress and completion.
<i>Mainstreaming</i>	Bierbaum et al. (2013), Ford and Berrang-Ford (2016), Preston et al. (2011), Woodruff and Stults (2016)	The action is written into other planning documents by the community, such as a hazard mitigation plan.
<i>Update Protocol</i>	Berke and Goldschalk (2009)	The plan provides methods to update its contents.
<i>Overall monitor</i>	Woodruff and Stults (2016)	The plan identifies who is responsible for overall monitoring.
<i>Overall timeline</i>	Kingsborough et al. (2016), Lobell et al. (2008), Olazabal et al. (2019)	The plan includes a schedule of updates and completion.

3.1.6 Cost

The cost of an action can be an estimate or the maximum funding available. Olazabal et al. (2017) argue that lack of financial resources is a major barrier to adaptation, so by including cost in the plan, decision-makers have valuable information to help prioritize projects.

3.1.7 Funding source

Closely related to cost considerations is the naming of a funding source for the adaptation action. A Biesbroek et al. (2013) meta-analysis of other planning literature concluded that 70% of the papers reviewed identified financial barriers. By specifying a funding source for actions at the planning stage, decisions over scarce resources are made easier. Another meta-analysis of planning papers by Hughes (2015) found securing a funding source could be the hardest part of the planning and implementation process.

3.1.8 Mainstreaming

Mainstreaming involves writing climate adaptation actions into other planning documents by the community, such as through a hazard mitigation or natural resource management plan (Ford and Berrang-Ford, 2016); Preston et al. 2011; Berke and Goldschalk, 2009). It can be an effective way to integrate climate policy into other areas of tribal governance and planning, but Bierbaum et al. (2013) warn that mainstreaming can potentially muddy adaptation evaluation efforts.

3.1.9 Protocol to update the plan

The ninth criterion assesses whether the plan provides methods for updating its contents (Berke and Goldschalk, 2009).

3.1.10 Overall monitor

The plan should also name a party responsible for monitoring the overall implementation and progress of the plan (Woodruff and Stults, 2016).

3.1.11 Overall timeline

The final criterion evaluates whether the plan provides a schedule for updates and completion of the entire document (Lobell et al. 2008; Kingsborough et al. 2016; Olazabal et al. 2019).

3.2 Adaptation action typologies

While the plan evaluation criteria help understand which actions have a greater likelihood of implementation, the criteria do not analyze the various ways in which tribes respond to climate change. Categorizing adaptation actions has been a prominent fixture of climate planning literature for two decades, since Smit et al. (2000) grouped actions into five areas

around timing, intent, spatial scope, form, and degree of necessary change. Biagini et al. (2014) took typology development one step further with a review of nearly 100 projects funded through the Global Environment Facility (GEF). The review netted 158 different adaptation activities in 70 countries. These actions were then divided into 10 typologies: capacity building, management and planning, practice and behavior, policy reforms, information, physical infrastructure, warning and observation systems, green infrastructure, financing, and technology. For their analysis, the authors found that mostly inexpensive “soft” measures focused on community input and preparation, such as capacity building with other jurisdictions, management and planning, and policy reform were common typologies in GEF’s adaptation-funding portfolio and are often some of the early actions in adaptation planning. Likewise, the adaptation actions identified in the tribal climate plans were categorized and analyzed based on the ten typologies from Biagni et al. (2014).

3.3 Interviews

To gauge the efficacy and success of actual implementation of the plans, solicitations for interviews were sent to tribal officials or outside consultants identified as administrators of the adaptation plans. Plan authors were cross-referenced with current tribal officials to choose participants. Four officials overseeing the implementation of four different plans were able to participate within the available timeframe in semi-structured interviews that lasted about 40 min each in the fall of 2020. Due to the sensitive nature of government funding for tribes and climate change, participants requested to remain anonymous so that they could speak more freely without fear of reprisal. Appendix 1 contains the script used to interview each participant.

Participants were asked about their background in climate and other environmental work with or for the tribe, experiences developing the plan, current implementation efforts, future implementation expectations, and potential plan updates. Each participant also helped write the adaptation plan and, at the time of the interview, were in the process of administering elements of the plan into the tribe’s overall climate strategy. The participants had nearly 100 years of combined experience addressing climate and other environmental problems for their respective communities. Collectively, the plan evaluation and interviews provide a snapshot of the struggles and successes around climate planning and action in Indigenous communities by identifying areas where plan language is more or less likely to transform into successful implementation and coupled with firsthand knowledge of which actions and goals are proceeding.

4 Findings

An examination of the 14 tribal climate adaptation plans using the 11 evaluation criteria found that few of the plans regularly incorporate information key to preparing proposed actions for implementation. Mainstreaming was the most common criterion included in the plans. The typology analysis showed a preference for “soft” adaptation measures, but the interviews with tribal climate professionals focused on “hard” infrastructure improvements. The interviewees recounted significant barriers to implementing plan specifics, with focus on staffing and financial constraints. The findings point to a need for more concise planning language and increased resources for tribes to facilitate more effective climate adaptation.

4.1 Plan evaluation

All 11 evaluation criteria appeared in at least one plan except for the identification of a party to monitor and evaluate implementation. The most common criteria were mainstreaming (8.5% of total actions), timeline for implementation (8.5%), and the identification of a party to implement the action (6.1%). Table 3 shows the distribution of the evaluation criteria. In a few instances, the majority of appearances of a criterion were found in a single plan, such as the comprehensive use of implementation timelines in the Swinomish Climate Change Initiative Climate Adaptation Action Plan (Swinomish Indian Tribal Community, 2010). Also, the Nez Perce sought to incorporate indicators to measure implementation (Clark and Harris, 2011). While no criterion was universal amongst all plans, mainstreaming did appear in 12 of the 14 plans.

The first criterion, naming a party to implement the action, appeared 34 times in the plans. The Puyallup Tribe enlisted hunting and fishing guides to “inform people of climate change impacts on wildlife and what they can do to help” as part of their strategy for natural resources adaptation (Puyallup Tribe of Indians, 2016). The Metlakatla Indian Community of Alaska volunteered its own tribal leadership to set an example on conservation practices such as “using water saving nozzles; repairing and fixing all leaks in water delivery systems; and using water catchment systems where practical to use rain-water for plants and gardens” (Scott et al. 2017). In each instance, the tribe delineates an individual, group, or entity to manage the implementation process. However, no plans provided a party to oversee the monitoring and evaluation of adaptation actions.

The text analysis netted a single example of measurable targets in three plans, the Chippewa Cree, the Nez Perce, and the Norton Bay Watershed plans. The Nez Perce Tribe formed targets around monthly attendance at fish and wildlife monitoring and planning meetings (Clark and Harris, 2011). The Norton Bay Watershed plan in Alaska strives to “list all ocean waters around the state as Water Quality-Limited Segments” under the federal Clean Water Act (Murray et al. 2013). The Chippewa Cree set a goal of completing one carbon footprint reduction project by its summer youth employees each year (Chippewa Cree, 2018). These targets are quantifiable and easy to measure for plan managers. The Nez Perce and Chippewa Cree plans also housed measurable indicators to accompany the targets. The Nez Perce Tribe formed indicators by counting attendees at meetings and recording what information they provided (Clark and Harris, 2011). The Chippewa Cree used “growing days,” the period from last frost to first frost, as an indicator, as well as cataloging the volume and types of food sold on their reservation (Chippewa Cree, 2018).

The Swinomish Indian Tribal Community extensively utilized timelines to schedule actions based on time to completion (Swinomish Indian Tribal Community, 2010). Timelines were either omitted from most other plans or used inconsistently. Similarly, cost estimates rarely factored into adaptation planning. Only the St. Regis Mohawk Tribe included costs in its plan by setting aside funds from settlements with Alcoa, Inc. and Reynolds Metals Company to improve water quality in Akwesasne (St. Regis Mohawk Tribe, 2013). Although only one tribe estimated project costs, about half of the tribes studied offered a possible funding source. For instance, the Navajo Nation plan includes tables at the end of each section detailing potential funding sources (Nania et al. 2014). Nome, AK added a timeline and potential funding sources for each action (Kettle et al. 2017).

Mainstreaming was one of the most utilized criteria found in the analysis with nearly 50 examples recorded across 12 different plans. The Yakama Nation recommended that climate actions and goals be incorporated into the Yakima River Basin Resource

Table 3 Frequency at which implementation criteria appeared in each tribal climate adaptation plan

	Puyallup	Nez Perce	Yakama	Norton Bay	St. Regis Mohawk	Metlakatla	Lummi	Red Lake	Navajo	Shinnecock	Swinomish	Chippewa Cree	ITCMI	Nome
Party ID (action)	1	1	1	0	10	10	4	1	3	0	1	0	0	2
Party ID (M and E)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Measurable target	0	1	0	1	0	0	0	0	0	0	0	1	0	0
Measurable indicator	0	11	0	0	0	0	0	0	0	0	0	2	0	0
Timeline	0	1	0	0	0	1	0	0	0	0	39	0	0	6
Cost	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Funding Source	2	0	0	1	8	0	2	0	9	0	0	0	0	4
Mainstreaming	2	2	10	1	6	5	7	4	4	1	2	3	0	0
Update protocol	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	Yes
Overall monitor	No	No	No	Yes	No	No	Yes	Yes	No	Yes	No	No	No	Yes
Overall timeline	No	No	No	Yes	No	No	Yes	No	No	Yes	Yes	No	No	No

Management Plan (Yakama Nation, 2016). The Lummi Nation vowed to update its coastal zone management plan with climate considerations (Kuhlman et al. 2016). For the collective plan developed through the Inter-Tribal Council of Michigan (ITCMI), the section on infrastructure noted inclusion of extreme weather effects in its disaster management plan (ITCMI, 2016). Mainstreaming was also referenced repeatedly by interview participants as a useful way to fund climate projects when capital for adaptation is scarce.

As for the final three criteria related to overall plan mechanics, few tribes offered mechanisms to update and evaluate the efficacy of the plan. Only three tribes provided directions to improve the plan in the future. The Shinnecock Nation plan includes a provision to have the plan reviewed annually and revised as needed (Shinnecock Indian Nation, 2013). Nome has an annual meeting where it “will provide opportunities to discuss the status of existing initiatives and changes in priorities. Data and documentation associated with completed priorities will be added as appendices to this plan, when available and relevant” (Kettle et al. 2017). The Swinomish plan recommends a 5-year review cycle to amend its contents and incorporate new information (Swinomish Indian Tribal Community, 2010). Five plans denominated a party to monitor plan progress. For the Shinnecock Nation, its tribal environmental department is charged with implementation of the plan (Shinnecock Indian Nation, 2013). In Norton Bay, staff for the Bay’s watershed council are tasked with coordinating plan implementation with advisory councils from participating villages (Murray et al. 2013). Nome relies on its tribal resource director to organize annual meetings and secure updates from the communities (Kettle et al. 2017). And finally, four tribes included a timeline to evaluate and improve the plan. The Swinomish Tribal Indian Community breaks down initiatives with timelines for the short-, medium-, and long-term (Swinomish Tribal Indian Community, 2010). Norton Bay provided a detailed timeline for short-term actions in the first year after publication (Murray et al. 2013).

4.2 Adaptation action typologies

For adaptation typologies, “soft” measures dominated the analysis. The most common typologies, as provided in Table 4, were management and planning (27%), policy reforms (20.9%), and information gathering and dissemination (20.1%). Tribes located on the Washington coast—the Swinomish Indian Tribal Community, Lummi Nation, and Puyallup Tribe of Indians—focused mainly on policy reforms, such as efforts by the Lummi Nation to preserve open space to mitigate flood hazards (Kuhlman et al. 2016). Alaska Native communities scored higher for information services through actions like knowledge exchanges between elders and youth on food preservation techniques in Nome (Kettle et al. 2017). Many “hard” measures, which can be expensive and time-consuming to implement, such as warning and observation systems (7.9%), green infrastructure (4.5%), and technological upgrades (3.2%), like the Puyallup’s proposed use of on-water floating nurseries to build resilience into fish hatcheries (Puyallup Tribe of Indians, 2016), appeared less often.

There is an observed imbalance between “soft” and “hard” measures included the plans. Nearly three quarters of the proposed actions were classified as “soft” measures. “Hard” typologies appeared less frequently and were also more likely to be absent from multiple plans. Surprisingly, many coastal communities, like Norton Bay, Nome, the Shinnecock Nation, and the Swinomish Indian Tribal Community, did not specifically include any warning or observation systems into their adaptation actions. Despite voicing concerns in

Table 4 Frequency at which each adaptation typology appeared in the tribal climate adaptation plans

	Puyallup	Nez Perce	Yakama	Norton Bay	St. Regis Mohawk	Metlakatla	Lummi	Red Lake	Navajo	Shinnecock	Swinomish	Chippewa Cree	ITCMI	Nome
<i>Capacity building</i>	5	6	11	11	13	1	3	2	8	1	1	10	0	6
<i>Management and planning</i>	6	3	56	2	17	11	7	8	30	2	7	0	0	1
<i>Practice and behavior</i>	2	2	18	6	15	14	4	2	36	1	6	5	0	0
<i>Policy reforms</i>	6	2	9	3	16	12	17	3	26	2	14	1	2	3
<i>Information</i>	4	4	21	14	11	4	7	10	15	1	5	8	1	7
<i>Physical infrastructure</i>	3	4	5	0	7	3	7	0	32	1	13	4	1	2
<i>Warning and observation systems</i>	1	0	7	0	10	5	1	7	11	0	0	1	1	0
<i>Green infrastructure</i>	4	2	0	0	0	1	2	1	9	2	2	1	1	0
<i>Financing</i>	1	0	4	13	9	0	4	0	2	0	0	0	0	2
<i>Technology</i>	1	0	1	2	1	0	1	0	6	1	1	2	1	1

their plans about climate impacts such as sea level rise, coastal erosion, species loss, and ocean acidification, the plans lacked measures to respond directly to these climate threats.

4.3 Interviews

The interviews revealed several barriers and success strategies in implementing the plans, such as lack of funding, inadequate staffing, pandemic disruptions, and increased youth engagement. The responding climate managers also spent considerably more time talking about the need for “hard” measures and big infrastructure projects to combat climate change. This revealed a disconnect between the perceived needs of tribal officials responding to climate change and the strategies including in planning documents. Each of the four plan managers interviewed expressed concern that the contents of the plan did not permit nimble and effective responses to climate threats.

Major funding and staffing constraints added to the challenges. Many actions were put on hold during the COVID-19 pandemic due to a lack of tribal government resources. Similarly, tribal government staff suffered from time and expertise constraints in implementing adaptation actions. Facing these barriers, participants still claimed implementation victories, especially by mainstreaming climate projects into other efforts, like hazard mitigation after a major storm event. Finally, the participants noted one unexpected benefit of climate planning—it reconnected youth in the community to the land and knowledge of tribal elders. In one instance, the tribe used younger residents to speak with elders and gather information about traditional responses to extreme weather and climate change. The youth shared that this opportunity was important in helping them form a stronger connection to the community. In total, the plan assessment and interviews display the adversity and promise inherent in the Indigenous climate response in America.

5 Discussion

The 14 plans delineate 556 proposed adaptation actions, strategies, objectives, and goals, with some of the proposed actions in various stages of implementation. The results of the adaptation plan assessment highlight the types of actions relevant to Indigenous climate response in the USA but also expose a lack of details on how to implement those actions that dominated the conversation with the interview participants. Overall, “soft” adaptation measures such as management and planning, policy reform, and information-gathering and dissemination dominated proposed tribal planning actions. Mainstreaming climate actions into other planning documents proved popular during the evaluation, but many of the other implementation criteria were used sparingly or confined to a single plan. The interviews contributed valuable insights into how communities translated their plans into actionable efforts at climate adaptation, despite formidable barriers posed by understaffing, limited technical expertise, and the COVID-19 pandemic.

5.1 Planning process constraints

Although many areas of advancement for Indigenous Peoples have recently benefitted from efforts to “indigenize” methodologies and evaluation standards, especially in fields linked closely to the effects of climate change such as public health (Donatuto et al. 2014), many of the plans evaluated for this study were based on templates or model plans offered by

universities and federal agencies. A few tribes did incorporate unique cultural aspects into planning documents, like how the St. Regis Mohawk Tribe prepared chapters in its plan on “Grand Mother Moon,” “the Four Winds,” and “the Creator” (St. Regis Mohawk, 2013). Just as the incorporation of Indigenous knowledge systems holds incredible potential to transform the global climate response (Cottrell, 2022), scholars should investigate how to blend Indigenous knowledge and culture into tribal planning efforts.

For most criteria, many tribal climate plans failed to register a single example. Two interview participants noted that the creation of their respective plans was incredibly rushed under tight deadlines from university and private partners to satisfy federal grant specifications. Future plan updates were expected to include more of the evaluation criteria. After a short absence, the U.S. government is once again offering funding up to \$150,000 per tribe for “Tribal Climate Resilience Grants” (Bureau of Indian Affairs, 2021). With renewed funding opportunities, some tribes may be able to update plans and incorporate more elements evaluated in this study.

5.2 The importance of detail in climate planning

The plan assessment revealed that many tribes used language to describe actions, goals, and recommendations that was light on details useful for facilitating implementation. Kingsborough et al. (2016) explained that this type of ambiguity could be beneficial as it allows for flexibility in how the community responds to climate change. Interview participants were asked about vague vs. specific language in climate planning. Two participants said that there were expectations that more specificity would be added in future updates to the plan. One remarked that the quick turnaround in writing the original plan did not leave the authors with enough time to properly develop and evaluate all of the elements helpful in making actions “shovel ready.” In one instance, the lack of specificity slowed efforts to apply for grants to implement certain climate projects. It could also complicate efforts to monitor and evaluate actions in the process of implementation by providing little guidance on how to measure the action’s impact or establish a reasonable timeframe for its completion. The participants seemed to recognize that specificity in future planning activities would produce dividends when opportunities arose to fund projects, but specificity could contribute toward other aspects of implementation as well, such as the effective monitoring and evaluation of actions.

When asked generally about implementation, interview participants wanted to discuss major issues advancing infrastructure projects. They spoke very little about “soft” measures, even though “soft” strategies were more prevalent in the plans and would be less expensive to implement. This seemed to reflect how tribal governments are prioritizing adaptation responses and focusing more on large-scale infrastructure projects. This emphasis could be a recognition that “soft” measures are insufficient to adequately address climate change or a desire by tribal governments to pursue more visible climate responses for their communities. None of the participants provided any explanation as to why they would concentrate on “hard” strategies over “soft” measures.

All interview participants spoke about at least some progress toward the tribe’s climate goals. Much of the successful activity came from the mainstreaming of climate priorities into other planning documents, in particular opportunities to utilize the Federal Emergency Management Agency’s (FEMA) grant funding for projects that would simultaneously mitigate hazards from natural disasters and foster adaptation to climate change. Unfortunately, the participants noted that FEMA funds a narrow set of projects and could not be relied

upon for most adaptation proposals. Regardless, all of the participants expected to continue to mainstream climate actions into other future plans, like emergency response and water or natural resource management documents, in order to take advantage of alternative funding sources. Mainstreaming could be a viable strategy to overcome funding barriers and involve more tribal government staff.

5.3 Implementation constraints

The results of the tribal climate adaptation plan assessment were light on many of the implementation criteria, like cost estimates, the identification of a party to monitor and evaluate response actions, and measurable targets for successful action implementation. However, the plans scored higher marks on mainstreaming, a party identified to lead implementation, and pinpointing a funding source for adaptation projects. The interviews complemented the plan analysis by exploring themes such as project funding, staffing constraints, and community buy-in. The challenges faced by Indigenous communities planning and implementing climate adaptation responses echo studies from non-Indigenous communities in the USA (Bierbaum et al. 2013; Woodruff and Stults, 2016) and globally (Araos et al. 2016), especially around the financial and technological barriers to implementation.

The only implementation criterion missing from all plans was the identification of a party to monitor and evaluate individual response actions. In a review of climate actions in the Global South, a collection of developing nations and communities located mainly in the Southern Hemisphere that suffer from some of the same financial, sovereign, and skilled-workforce barriers faced by Indigenous communities in the United States, Araos et al. (2016) pointed to a lack of oversight and monitoring contributing to low reporting on adaptation actions. These types of institutional constraints were also cited by Bierbaum et al. (2013) as a significant obstacle to climate plan implementation. Another study found that 74% of respondents mentioned staffing as a concern (Carmin, et al. 2012). Implementing complex, long-term climate solutions can be difficult without the personnel necessary to do so.

Limited technical knowledge from existing tribal government staff also limited implementation efforts. Three of the four interview participants voiced concern that their communities suffered from staffing shortfalls and the technical expertise required to complete essential climate response tasks like the monitoring of local temperature, air quality, water quality, and ecosystem health that are vital to quantifying climate impacts and forming adaptation strategies. Berrang-Ford et al. (2014: 447) note that “technology is a likely causal pathway through which institutional capacity may facilitate adaptation.” The dearth of technology for observation of different climate phenomena and staffing constraints in tribal governments are barriers impeding climate response cited by all four interview participants.

Participants were often the only staff working regularly on climate issues for their respective tribal governments. However, adaptation projects necessitate involvement from staff in other sectors of government, and those personnel often had less familiarity with climate issues. To combat low technical expertise and time availability with tribal staff, one participant discussed the creation of a “hub of knowledge.” This hub would act as a clearinghouse for various tribal government departments, outside consultants, local universities, and community organizations to pool resources, energy, and insight into planning, managing, and solving climate risks. Climate hubs within

tribal governments might help overcome the lack of detail and unclear language, also referred to as “muddy waters” by Araos et al. (2016), that so often plagues inter-department and interorganizational responses to climate threats and could act like localized versions of the climate action science centers operated by the U.S. Department of the Interior or the climate hubs administered by the U.S. Department of Agriculture. Providing staff with a central repository for climate expertise and resources could help overcome workforce constraints that limit current efforts at implementation.

Limited financial resources were the number one barrier to implementation cited by the interview participants. Budgetary constraints are a common impediment to climate action (Amundsen et al. 2010). In one study, 70% of the literature reviewed pinpointed financial barriers as a major problem addressing climate change (Biesbroek et al. 2013) and another found that 88% of U.S. cities suffering from similar budgetary shortages (Carmin et al. 2012). There are a few approaches cited in other studies to overcome budget shortfalls. First, communities can seek ways to better utilize existing funds. In one example, Burch (2010) found that, by reconfiguring path dependent institutional structures, communities could take advantage of existing resources through integration of climate needs into existing governing structures. Similarly, Ford and King (2015) recommend that climate projects be a part of the government’s baseline funding stream through statutory measures, with Olazabal et al. (2019: 284–86) explaining that “no budget assignment means no resources for implementation and no plan to acquire them.” By reimagining local budgets and using statutory requirements to embed climate response, scholars argue that communities can ensure adequate funding for climate projects in the future.

The ongoing Coronavirus pandemic brought a new wrinkle to tribal budget and workforce limitations. Interview participants expressed concern over the impact lost revenues and reduced staffing capacities will have for ongoing climate efforts. One interviewee said that climate adaptation activities were on hold until revenues normalize, and staff resume regular schedules again. The U.S. Centers for Disease Control and Prevention reported that for the first half of 2020, 1.3% of total COVID-19 infections in 23 states afflicted American Indian and Alaska Native (AIAN) peoples, despite AIAN groups only accounting for 0.7% of the total population in those areas (Hatcher et al. 2020). The same health and socio-economic disparities that make Indigenous Peoples susceptible to climate change are also making them higher risk to contract COVID-19. Many Indigenous communities in the USA are reliant on gaming and tourism to generate revenues that fund tribal government operations (Smith, 2000). One economic impact report put tribal losses from shuttered gaming operations at \$4.4 billion during the first 6 weeks of pandemic business closures in March and April 2020 (Meister Economic Consulting, 2020).

Given the significant challenges in funding, staff availability, and technical expertise plaguing tribal governments, the successful mainstreaming of climate adaptation strategies is an example of the “indigenuity” that underlies the hundreds of actions tribes have already taken to adapt to climate. Indigenuity, a term coined by Indigenous scholar Daniel Wildcat, envisions balance between people and the natural environment, full of rights and responsibilities to steward meaningful relationships with the land and fellow humans (Wildcat, 2013). In this respect, tribal climate planning has been a success. Many of the participants offered stories about the planning process and how it helped reconnect the youth to the land and the knowledge of their elders. Community benefits such as these are hard to quantify but contribute greatly to cultural, as well as ecological, health.

6 Conclusion

These findings constitute an attempt at analyzing the implementation strategies and outcomes from the first generation of tribal climate adaptation plans. Climate planning scholars caution that early assessments of climate planning have little guidance to direct planning activities outside of models and suggested behaviors. However, Preston et al. (2011: 421) write that “the greatest utility of existing adaptation planning may be ‘learning-by-doing’ through the sharing of knowledge and the experience gained.” This goes hand in hand with Bierbaum et al.’s (2013) recommendation to share lessons learned and restart the entire adaptation process again. There is concern that a knowledge gap will form for governments that lag behind in adaptation planning (Amundsen et al. 2010). The plans analyzed in this study can serve as a preliminary roadmap for the hundreds of Indigenous communities in the United States struggling with climate change and looking for ways to apply local knowledge and “indigenuity” to their environmental needs.

The results in this study highlight how some Indigenous communities have produced climate adaptation strategies through careful planning despite significant financial, staffing, and information barriers. Mainstreaming climate policies into other planning activities was nearly universal amongst tribes engaged in climate planning and led to many successful implementation outcomes. Through inclusive community engagement and project specificity, Indigenous communities can plan for climate risk, grow knowledge bases, and be prepared when opportunities arise to fund climate adaptation.

Appendices

Appendix 1. Interview questions

Background

1. What is your current position with the tribe (or organization working closely with the tribe)?
2. Have you held any other positions with the tribe?
3. How long have you worked with or for the tribe?

Plan development

4. Did you participate in the drafting of the tribe’s climate adaptation plan?
 - a. If yes, what role did you play in the plan’s development?
 - b. Was development led by members of the tribe or an outside institution (like a local university or non-profit)?

Plan implementation

5. Is the tribe currently pursuing any of the goals or action items listed in the adaptation plan?

If yes:

- a. How far along is the tribe in completing its climate adaptation goals?
- b. Which tribal government departments are involved in the projects? Are outside institutions or organizations also involved?
- c. How is the tribe funding these projects?
- d. Has the tribe encountered any roadblocks in completing its climate adaptation goals?

If not:

- a. What barriers does the tribe face in implementing the adaptation plan?

- b. Do you expect these barriers to ease up in the future?
- c. Has the tribe considered addressing climate planning through other planning documents like hazard mitigation or emergency response?

Plan maintenance

- 6. Does the tribal council/government have a committee or group that meets regularly to discuss progress on the adaptation plan?
- 7. Does the tribe plan on updating the adaptation plan in the future? If yes, is there a person designated to lead the update process?

Reflections

- 8. Is there anything you would change about the process of creating the adaptation plan? Is there anything that you felt worked well?
- 9. Anything you would add or remove on an update?
- 10. Is there anything that you feel other institutions (like the federal government or non-profit organizations, for example) could contribute to either plan development or implementation?
- 11. Do you think tribes can effectively adapt to climate change without participating in activities like the creation of adaptation plans?
- 12. Any advice for other tribes considering writing their own climate adaptation plans?

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Declarations

Conflicts of interest The author declares no conflict of interest.

References

- Amundsen H, Berglund F, Westskog H (2010) Overcoming barriers to climate change adaptation—a question of multilevel governance? *Environ Plan C: Govern Policy* 28(2):276–289
- Araos M, Austin SE, Berrang-Ford L, Ford JD (2016) Public health adaptation to climate change in large cities: a global baseline. *Int J Health Serv* 46(1):53–78
- Baker I, Peterson A, Brown G, McAlpine C (2012) Local government response to the impacts of climate change: an evaluation of local climate adaptation plans. *Landsc Urban Plan* 107(2):127–136
- Berke P, Godschalk D (2009) Searching for the good plan: a meta-analysis of plan quality studies. *J Plan Lit* 23(3):227–240
- Berrang-Ford L, Ford JD, Lesnikowski A, Poutiainen C, Barrera M, Heymann SJ (2014) What drives national adaptation? A global assessment. *Clim Change* 124(1–2):441–450
- Biagini B, Bierbaum R, Stults M, Dobardzic S, McNeeley SM (2014) A typology of adaptation actions: a global look at climate adaptation actions financed through the Global Environment Facility. *Glob Environ Change* 25:97–108
- Bierbaum R, Smith JB, Lee A, Blair M, Carter L, Chapin FS, Fleming P, Ruffo S, Stults M, McNeeley S, Wasley E, Verduzco L (2013) A comprehensive review of climate adaptation in the United States: more than before, but less than needed. *Mitig Adapt Strateg Glob Chang* 18(3):361–406
- Biesbroek GR, Klostermann JE, Termeer CJ, Kabat P (2013) On the nature of barriers to climate change adaptation. *Reg Environ Change* 13(5):1119–1129

- Burch S (2010) Transforming barriers into enablers of action on climate change: Insights from three municipal case studies in British Columbia, Canada. *Glob Environ Change* 20(2):287–297
- Carmin J, Nadkarni N, Rhie C (2012) Progress and challenges in urban climate adaptation planning: results of a global survey. In: *Progress and Challenges in Urban Climate Adaptation Planning: Results of a Global Survey*. Massachusetts Institute of Technology (MIT)
- Chippewa Cree Tribe of the Rocky Boy's Indian Reservation (2018) Climate adaptation plan 2018
- Clark K, Harris J (2011) Clearwater river subbasin (ID) climate change adaptation plan. Nez Perce Tribe Water Resources Division
- Cottrell C (2022) Avoiding a new era in biopiracy: including indigenous and local knowledge in nature-based solutions to climate change. *Environ Sci Policy* 135:162–168
- Donatuto J, Grossman E, Konovsky J, Grossman S, Campbell LW (2014) Indigenous community health and climate change: integrating biophysical and social science indicators. *Coast Manage* 42(4):355–373
- Dupuis J, Biesbroek R (2013) Comparing apples and oranges: the dependent variable problem in comparing and evaluating climate change adaptation policies. *Glob Environ Change* 23(6):1476–1487
- Eisenack K, Stecker R (2012) A framework for analyzing climate change adaptations as actions. *Mitig Adapt Strateg Glob Chang* 17(3):243–260
- Ford JD, Berrang-Ford L (2016) The 4Cs of adaptation tracking: consistency, comparability, comprehensiveness, coherency. *Mitig Adapt Strateg Glob Chang* 21(6):839–859
- Ford JD, King D (2015) A framework for examining adaptation readiness. *Mitig Adapt Strateg Glob Chang* 20(4):505–526
- Füssel HM (2007) Adaptation planning for climate change: concepts, assessment approaches, and key lessons. *Sustain Sci* 2(2):265–275
- Hatcher S, Agnew-Brune C, Anderson M, Zambrano L, Rose C, Jim M, Baugher A, Liu G, Patel S, Evans M, Pindyck T, Dubray C, Rainey J, Chen J, Sadowski C, Winglee K, Penman-Aguilar A, Dixit A, Claw E, Parshall C, Provost E, Ayala A, Gonzalez G, Ritchey J, Davis J, Warren-Mears V, Joshi S, Weiser T, Echo-Hawk A, Dominguez A, Poel A, Duke C, Ransby I, Apostolou A, McCollum J (2020) Covid-19 among American Indian and Alaska native persons- 23 States, January 3, 2020- July 3, 2020. Center for Disease Control and Prevention Morbidity and Mortality Weekly Report, vol 69
- Hughes S (2015) A meta-analysis of urban climate change adaptation planning in the US. *Urban Clim* 14:17–29
- Inter-Tribal Council of Michigan (ITCMI) (2016) Michigan tribal climate change vulnerability assessment and adaptation planning: Project report
- IPCC (2018) Summary for policymakers. In: Masson-Delmotte V, Zhai P, Pörtner H-O, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, Matthews JBR, Chen Y, Zhou X, Gomis MI, Lonnoy E, Maycock T, Tignor M, Waterfield T (eds.) *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*
- IPCC (2021) Summary for Policymakers. In: Masson-Delmotte V, Zhai P, Pirani A, Connors SL, Péan C, Berger S, Caud N, Chen Y, Goldfarb L, Gomis MI, Huang M, Leitzell K, Lonnoy E, Matthews JBR, Maycock TK, Waterfield T, Yelekçi O, Yu R, Zhou B (eds) *Climate change 2021: The physical science basis. Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change*. Cambridge University Press, Cambridge, pp. 3–32. <https://doi.org/10.1017/9781009157896.001>
- Jantarasami LC, Novak R, Delgado R, Marino E, McNeeley S, Narducci C, Raymond-Yakoubian J, Singletary L, Powys Whyte K (2018) Tribes and indigenous peoples. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, Stewart BC (eds) *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program, Washington, pp. 572–603
- Jay A, Reidmiller DR, Avery CW, Barrie D, DeAngelo BJ, Dave A, Dzaugis M, Kolian M, Lewis KLM, Reeves K, Winner D (2018) Overview. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, Stewart BC (eds) *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program, Washington, pp. 33–71
- Kettle N, Martin J, Sloan M (2017) Nome tribal climate adaptation plan. Eskimo Community and The Alaska Center for Climate Assessment and Policy, Fairbanks, AK
- Kingsborough A, Borgomeo E, Hall JW (2016) Adaptation pathways in practice: mapping options and trade-offs for London's water resources. *Sustain Cities Soc* 27:386–397
- Kobayashi VB, Mol ST, Berkers HA, Kismihok G, Den Hartog DN (2018) Text classification for organizational researchers: A tutorial. *Organ Res Methods* 21(3):766–799
- Kuhlman K, Freimund J, Gabrisch G (2016) Lummi Nation climate change mitigation and adaptation plan: 2016-2026

- Lesnikowski A, Biesbroek R, Ford J, Berrang-Ford L (2018) Comparative measurement of climate change adaptation policies: a policy instruments. *J Comp Policy Anal: Res Pract* 11(1):7–31
- Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL (2008) Prioritizing climate change adaptation needs for food security in 2030. *Science* 319(5863):607–610
- Magnan AK (2016) Metrics needed to track adaptation. *Nature* 530(7589):160–160
- Meister Economic Consulting (2020) Coronavirus impact on tribal Gaming. [Meistereconomics.com](https://www.meistereconomics.com/coronavirus-impact-on-tribal-gaming). June 2, 2020. Available at: <https://www.meistereconomics.com/coronavirus-impact-on-tribal-gaming>. Accessed 5 July 2022
- Murray E, Ryan J, Shepard H (2013) Climate adaptation and action plan for the Norton bay watershed, Alaska
- Nania J, Cozzetto K, Gillett N, Druen S, Tapp AM, Eitner M, Baldwin B (2014) Considerations for climate change and variability adaptation on the Navajo Nation
- Olazabal M, Galarraga I, Ford J, Lesnikowski A, de Murieta ES (2017) Towards successful adaptation: a checklist for the development of climate change adaptation plans. Basque Centre for Climate Change, Lejona
- Olazabal M, Galarraga I, Ford J, Sainz De Murieta E, Lesnikowski A (2019) Are local climate adaptation policies credible? A conceptual and operational assessment framework. *Int J Urban Sustain Dev* 1–20
- Preston BL, Westaway RM, Yuen EJ (2011) Climate adaptation planning in practice: an evaluation of adaptation plans from three developed nations. *Mitig Adapt Strateg Glob Chang* 16(4):407–438
- Puig D, Olhoff A, Bee S, Dickson B, Alverson K (eds) (2016) United Nations environment programme Puyallup Tribe of Indians (2016) Climate change impact assessment and adaptation options. A collaboration of the Puyallup tribe of Indians and cascadia consulting group
- Scott J, Wagner A, Winter G (2017) Metlakatla Indian community climate change adaptation plan
- Shinnecock Indian Nation (2013) Climate change adaptation plan
- Smit B, Burton I, Klein RJ, Wandel J (2000) An anatomy of adaptation to climate change and variability. In: Societal adaptation to climate variability and change. Springer, Dordrecht, pp 223–251
- Smith DH (2000) Modern tribal development: paths to self-sufficiency and cultural integrity in Indian country (Vol. 4). Rowman & Littlefield
- St. Regis Mohawk Tribe (2013) Climate change adaptation plan for Akwesasne
- Swinomish Indian Tribal Community (2010) Swinomish climate change initiative climate adaptation action plan
- Tang Z, Brody SD, Quinn C, Chang L, Wei T (2010) Moving from agenda to action: evaluating local climate change action plans. *J Environ Plan Manag* 53(1):41–62
- U.S. Bureau of Indian Affairs (2021) Program to support tribal climate resilience grants and ocean and coastal management planning grants- federally recognized tribes. [Solicitation of Proposals]. TEMP-11663
- U.S. Census Bureau (n.d.) Navajo Nation reservation and off-reservation trust land” and “Annette Island Reserve.” My Tribal Area. [Census.gov](https://www.census.gov). Accessed 5 Oct 2020
- Wildcat DR (2013) Introduction: climate change and Indigenous peoples of the USA. *Clim Chang* 120(3):509–515
- Woodruff SC, Regan P (2019) Quality of national adaptation plans and opportunities for improvement. *Mitig Adapt Strateg Glob Chang* 24(1):53–71
- Woodruff SC, Stults M (2016) Numerous strategies but limited implementation guidance in US local adaptation plans. *Nat Clim Change* 6(8):796–802
- Yakama Nation (2016) Climate adaptation plan for the territories of the Yakama Nation

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