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Research, part of a Special Feature on Resilience and Change in Arctic Alaska

Comparing adaptive capacity of Arctic communities responding to environmental change

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ABSTRACT. Adaptive capacity (AC) is a widely used concept denoting assets or resources that people or a system can draw upon to cope with environmental change. When applied to a community, careful definition and measurement of AC is essential for identifying patterns and generating findings that may be useful for policy and transferable to other places. We identified and compared measures of 22 indicators for eight communities on Alaska's North Slope, based on consistency with theory, availability of data, and measurable community differences. Despite many cultural and institutional similarities, we found systematic differences among communities in each of the seven AC domains measured. Although every community had strengths in some domains, we could divide communities into three groups: high overall AC (one community), moderate overall AC (four communities), and low overall AC (three communities), based on average rank order across all domains. The comparative approach we developed can be helpful in identifying productive policy opportunities for strengthening community AC.

Key Words: *adaptive capacity; Arctic communities; climate change; Iñupiat; local institutions; oil development; resilience*

INTRODUCTION

Climate change increasingly affects social-ecological systems (SESs) of rural communities, especially in the Arctic, which is warming faster than other regions (Carson and Peterson 2016, IPCC 2019). Arctic communities are also simultaneously adapting to other forces of change such as resource development, changes in national policies, and globalization. As communities navigate these changes, some may fare better than others in maintaining well-being, population, and SES resilience. How can one understand and measure the main factors predicting different outcomes for arctic communities, and potentially use the findings to improve outcomes for communities overall?

To address this question, we undertook a comparative study of the eight largely Iñupiat communities of the North Slope (NS) region of Alaska. Most NS residents combine wage jobs and other cash income with subsistence harvesting in a SES that has proven resilient over many years, as residents have adapted to rapid environmental and social change (Braund and Kruse 2009, BurnSilver et al. 2016) Whether those positive outcomes can be maintained in the future as the changes continue and intensify is uncertain, and depends on community adaptive capacity.

Adaptive capacity (AC) is a widely used concept denoting assets or resources that enhance the ability of people individually or collectively to accommodate change and variability without causing harm (Turner et al. 2003, Adger 2006, IPCC 2014). The objective of the study was to develop and apply methods to provide empirical comparisons of AC across multiple communities. Evaluating the specific role of AC in reducing community vulnerability is challenging, requiring a framework that is both theoretically consistent and can distinguish drivers of change from components of AC and SES outcomes in a comparative empirical setting (Berman et al. 2017). We offer such a framework, and apply it to discuss drivers of change and AC that might affect well-being in NS communities.

Vulnerability, resilience, and adaptive capacity

Over the past two decades AC has emerged as a central concept in vulnerability assessments, to a great extent in response to concern for climate-linked environmental change, and in resilience theory, motivated by concerns for a larger set of social-ecological changes. In early climate change assessments, AC was defined as the ability of a system to adjust to change (including variability and extremes) to reduce potential damages, take advantage of opportunities, or cope with the consequences (IPCC 2001). Many studies have focused on introducing and refining various "vulnerability frameworks" to explore the relationship between three linked elements of vulnerability: exposure, sensitivity, and AC (IPCC 2001). Central to this enterprise has been identifying the critical variables (Smit and Pilifosova 2001, Smit and Pilifosova 2003, Turner et al. 2003), barriers (Brooks and Adger 2005), and the nuanced dimensions of AC (Hovelsrud et al. 2010). Scholars have focused on a variety of themes, including institutional arrangements and governance systems (Young et al. 2008, Armitage and Plummer 2010, Folke et al. 2005), gender (Denton 2002), perceptions of risk (Blair and Kofinas 2020), the role of power dynamics (Woroniecki et al. 2019), processes of navigated transformation (Olsson et al. 2006), psycho-social conditions (Grothmann and Patt 2005), livelihood diversity (Ellis 1998, BurnSilver and Magdanz 2019), and forms of social capital (Adger 2003).

Studies applying the resilience lens have looked more broadly to consider the social-ecological dynamics and their implications to adaptability (Walker et al. 2004, Chapin et al. 2009). For example, Carpenter and Brock (2008) noted the role of the adaptive cycle and extent to which traps (conditions that prevent adaptation), such as institutional rigidity, can affect outcomes. The conceptual relationship between vulnerability, resilience, and AC has taken a variety of forms in the literature (Cutter et al. 2008). For this study we focus more narrowly on the use of the term AC as a set of assets (resources or tools) that people can use, either individually or collectively, as they undertake activities to reduce vulnerability and promote positive well-being outcomes in response to various drivers of change (Smit and Pilifosova 2001, Adger et al. 2007; Fig. 1). These activities also increase SES resilience if they maintain or strengthen the structure and function of human-environment interactions; however, they

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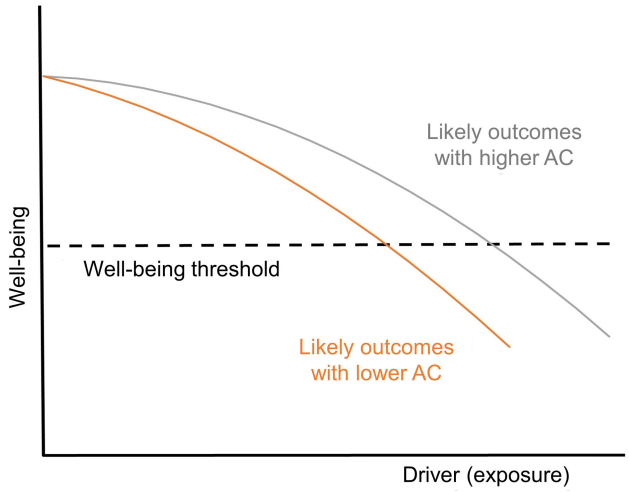
promote SES transformation if they change these system properties (Folke 2006, Engle 2011). This interpretation of AC aligns with the concept of AC that promotes robustness of the SES (Anderies et al. 2004).

Fig. 1. Vulnerability (likely outcomes falling below a threshold) depends on driver level or rate (exposure), initial well-being, sensitivity (incremental change in likely outcomes, slope of curve), and adaptive capacity (AC). AC increases the range of driver states with likely outcomes above the threshold.

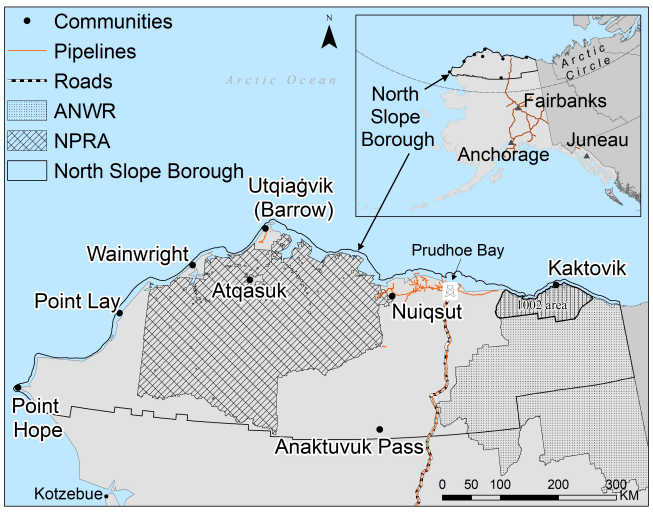


For the most part, vulnerability analyses, and to a lesser extent resilience theory, have been based on qualitative analyses of one or several case studies. Relatively few studies have sought to measure AC using quantitative data, and even fewer of these have undertaken comparative studies (Defiesta and Rapera 2014, Lockwood et al. 2015). Although a multitude of studies have discussed vulnerability, resilience, and adaptive capacity in the circumpolar Arctic region (Arctic Monitoring and Assessment Programme 2017), we are not aware of any studies that used quantitative as well as qualitative data to compare AC systematically among Arctic communities. Our comparative study of AC of the eight Iñupiat communities in Alaska's North Slope region was motivated by the need to bring greater rigor to community assessments of AC in ways that both support theory building and policy making. We undertook this enterprise with the understanding that comparing AC with mainly publicly available data alone is insufficient by itself to provide a full assessment of community AC. A full assessment would include an evaluation arising from a strong participatory process led by community residents. The logistics of coordinating such a process with a large number of communities would be difficult and labor intensive. This analysis explores what is feasible using publicly available data.

The Alaska North Slope region and communities

The North Slope Borough (NSB) is a county-level government jurisdiction encompassing about 230,000 km² of Arctic Alaska (Fig. 2). The borough's population of 9430 (U.S. Census Bureau 2010) includes over 2600 oilfield shift workers residing in industrial work camps, with the remainder residing in eight small predominantly Iñupiat communities. North Slope Iñupiat, an Indigenous Inuit population, continue to harvest wild foods from the land, rivers, and ocean with hunting and fishing activities that typically involve cooperation among multiple households (BurnSilver et al. 2016). These subsistence activities maintain culture and social connections as well as providing food (Braund and Kruse 2010, Kofinas et al. 2016a). Utqiaġvik (formerly Barrow), county seat for the NSB and headquarters for Arctic Slope Regional Corporation (ASRC), is the largest community, with a population of 4469, and has the lowest concentration of Indigenous residents, at 61.2%. The other communities are smaller, with populations of 244 to 672, and are over 80% Indigenous (U.S. Census Bureau 2010). Most are located along the Arctic Ocean. Anaktuvuk Pass is located inland in the Brooks Range, and Atqasuk and Nuiqsut lie inland on north-flowing rivers that provide access to coastal regions and marine resources. The incorporation of the NSB in 1972 allowed NS communities to collect property tax revenues from oil and gas infrastructure to improve public facilities and provide services and jobs to residents (Knapp and Morehouse 1991). New services offered by the NSB included resource management critical to subsistence harvesting.

Fig. 2. The North Slope study region and communities. ANWR: Arctic National Wildlife Refuge. NPRA: National Petroleum Reserve Alaska.



Drivers of change for Alaska North Slope communities

Drivers of change are forces affecting the community, which could be environmental, social, or a combination of the two. Although they appear in the literature as links among system components as well as external forces, we consider only external drivers, which we refer to simply as "drivers". We use drivers rather than the more conventional term "exposure" to emphasize that they are exogenous to the region. Sensitivity, that is, the degree to which a disturbance affects or modifies the system (Gallopin 2006), has been treated in a variety of ways in the vulnerability literature. Here, we define it functionally as the incremental change in the system caused by a small change in a driver: i.e., the slope of curve in Fig. 1. Vulnerability of the SES to a specific adverse driver level or rate depends on the initial well-being, sensitivity, and AC (Adger 2006). We therefore define AC as a set of assets, resources,

or tools that reduce vulnerability by expanding the "coping range," or range of driver states generating a low probability of adverse outcomes (Smit and Wandel 2006, Kofinas et al. 2013). Although we describe AC specific to environmental and land use change, some components of AC may be useful in a variety of ways, as people respond to cumulative effects of multiple co-occurring drivers (Carpenter et al. 2012). Nevertheless, some components of AC may help mitigate vulnerabilities caused by a specific driver, for example, infrastructure to address flood hazards versus infrastructure to address permafrost thaw, making it necessary to articulate the specific drivers creating potential vulnerabilities to this particular community or region under study. Here we focus on the implications of AC to three forces for change particularly relevant to the region.

Climate change

Climate change is already affecting Arctic subsistence livelihoods and community living conditions in several ways. The loss of sea ice, changes in seasonality, and warmer temperatures are making hunting more difficult and travel riskier, as well as changing the seasonal distribution of subsistence resources, such as walrus and several seal species (Carson and Peterson 2016, Huntington et al. 2016, IPCC 2019). Diminished shore-fast ice and thawing of permafrost, combined with increased extreme weather events, has hastened coastal erosion (Gibbs and Richmond 2015). Thawing permafrost threatens infrastructure such as roads, buildings, and traditional ice cellars (Arctic Monitoring and Assessment Programme 2017). Climate change increases uncertainty not only through directional change, but also by potentially increasing climate variability.

Oil and gas development

The NS has been a major oil-producing area since the 1970s. Initially oil and gas activity were limited to the vicinity of Prudhoe Bay, but production and the associated pipeline network now extends west into the Alaska National Petroleum Preserve (Fig. 2), and in nearby offshore areas. Several areas of the Alaska National Petroleum Reserve around Nuiqsut are in various stages of development. This development has had adverse environmental effects that will likely increase as activities expand (Raynolds et al. 2013). Oil exploration has also taken place and could occur in the future around Wainwright and Kaktovik (BLM 2018, 2019). Besides local environmental change, oil development profoundly affects all NSB communities through its role in the cash economy.

Other drivers

Ecotourism is expanding near Anaktuvuk Pass and Kaktovik, which are surrounded by federal protected areas. Cruise ship tourism is currently limited because of remoteness and lack of infrastructure, but could expand as sea ice retreats, depending on trends in global tourism markets (Lasserre and Pelletier 2011, Lasserre et al. 2016). At some level of increase, tourism could impair harvesting activities (Maher 2007). State and federal policies affect NS communities in numerous ways, including management of federal lands and natural resources, regulation of resource development, tax and spending policies, and devolution of authority to local governments. North Slope communities also confront the same forces of technological change and globalization that affect communities everywhere.

METHODS

Desirable outcomes and activities to achieve them

AC may relate to both social and ecological aspects of the SES, and is context specific (Smit and Wandel 2006). Since AC embodies assets that people use to improve SES outcomes, we begin by identifying desirable outcomes and activities that achieve them. North Slope community residents have previously identified community goals that include continued practice of traditional subsistence activities, availability of local jobs, and local autonomy. They have also described desirable futures that include use of Iñupiaq language, high-quality education, public safety, local autonomy, and respect for elders (Kruse et al. 2004, Lovecraft 2017, Blair and Kofinas 2020). Indigenous language and formal education are assets that could assist adaptation (i.e., they are components of AC). Other goals reflect potential SES outcomes. Our assessment of AC for communities of Alaska's NS focused on assets that may help achieve these outcomes directly, or assist activities that could improve them.

North Slope residents engage in a number of activities that reduce the likelihood of adverse outcomes as they adapt to environmental uncertainty and change that are similar or analogous to risk-mitigating activities observed elsewhere in the Arctic and around the world (Agrawal 2010, Lovecraft and Eicken 2011, Berman 2013). Community residents diversify livelihoods by targeting different subsistence species and having some household members work for pay while others harvest wild foods. They share harvests, move among communities, and invest in tools and equipment (Kofinas et al. 2016a). AC assets reduce vulnerability by increasing the effectiveness of these activities to mitigate risk.

Adaptive capacity domains and indicators

Studies that discuss indicators to measure AC have generally partitioned AC into domains (dimensions) that they use to group sets of related indicators. Authors differ in the articulation of the domains (e.g., Sen 1983, Scoones 1998, Ford and Smit 2004, Tol and Yohe, 2007, Hinkel 2011). With specific reference to the Arctic, Kofinas et al. (2016a) defined seven domains of AC in the Arctic Resilience Report (ARR): natural capital (natural resources and ecosystems providing ecosystem services), social capital (capacity of people to work together to solve problems), cultural capital, human capital (education and skills), financial capital (access to wealth in the market economy), physical infrastructure, and knowledge assets. We adjusted the ARR domains somewhat to fit the NS context (Table 1), dividing natural capital into two subdomains (physical geography and ecosystem health). In other regions, geographic features affecting adaptation might include permafrost/soils, flood hazards, water scarcity, etc.; however, in the North Slope case, what distinguishes communities is their relative remoteness. Another geographic characteristic that distinguishes NS communities is whether they are located inland or on the coast. No coastal community has a harbor, so the primary effect of a coastal location is ecological, as it gives coastal residents access to a greater diversity of harvestable fish and wildlife resources.

The ARR includes institutions and governance systems as part of social capital, while noting that they play an important role in hindering or enabling communities to utilize other AC tools to

Table 1. Domains, implications to adaptation, and indicators of adaptive capacity for Alaska North Slope communities.

Adaptive capacity domain Implications to adaptation	Indicator	Measure(s)
Physical geography: remoteness		
Remoteness raises the costs of shipping goods and impedes mobility.	Travel cost to urban area	Price and travel time of commercial flight
	Air service quality	Number of flight segments, daily jet service
	Seasonal road access	Ice road link to road system (Y/N)
Ecosystem health		
Diversity of harvested species improves food security by reducing dependence on any one potentially uncertain resource; can also affect human health	Ecological diversity	Diversity of potential food sources
	Development disturbance	Oil and gas activities near community (Y/N)
	Harvesting opportunities	Subsistence whaling access
Physical infrastructure		
Provides housing, medical and fire-fighting services, internet access, places for community gatherings, roads, water and sewer services.	Housing quality	Crowded housing, plumbing facilities
	Housing affordability	Housing cost as percentage of income
	Telecommunications access	Fiber optic cable to community (Y/N)
	Health care facilities	Hospital in community (Y/N)
	Public safety facilities	Jail in community (Y/N)
Human capital		
The skill set of residents to know and act, including leadership and "how to" knowledge	Education investment	Post-secondary education, high-school graduation, standardized test scores
Social and cultural capital		
Provides access to resources within and beyond the community; can support subsistence activities	Investment in social capital	Sharing of subsistence foods among households
	Investment in cultural capital	Subsistence participation: hunting/fishing and other skills
	Social and cultural capital	Per capita whaling crews organized in the community
	Access to Indigenous knowledge	Iñupiat language spoken at home
Financial capital		
Allows for purchasing goods and services, and making investments.	Diversity of cash economy	Percent employment in local government
	Local business strength	Village corporation dividend paid in recent years
	Access to capital	Commercial bank office in community
Institutional capital		
Allows community preferences to be considered in various areas of governance; can affect quality and quantity of most other AC domains.	Formal local government	City government incorporated under state law
	Cross-scale governance	Representation on co-management boards
	Public safety response	Local police officers stationed in community

mitigate risks (Hovelsrud et al. 2010) that might otherwise remain latent and not activated (Nelson et al. 2007, Engle 2011). Because of the importance of institutions for the NS case and their role in mobilizing other types of AC, we placed institutions in a separate domain. One may theoretically distinguish cultural capital (shared beliefs and practices) from social capital that embeds these practices in society (social networks and sharing systems); however, we followed Tol and Yohe (2007) and combined them because they are difficult to distinguish empirically in North Slope Iñupiat communities. The primary mechanisms for building social capital in these communities involve participation in activities that bring members of different households together as they carry out subsistence livelihoods. Participating in these activities builds cultural capital as well, by transferring traditional ecological knowledge, harvesting and other livelihood skills, and Iñupiaq language across generations

Acknowledging the potential importance of knowledge assets and technology in AC, we omitted them for practical reasons: knowledge assets are difficult to measure, and differences among NSB communities are likely to be slight. Instead, we relied on the human capital and social and cultural capital domains to address the capacity of residents to access and use knowledge assets in their adaptation activities. We addressed some AC domains that are difficult to measure by observing local investments that build unobserved AC assets. In measuring investment flows to substitute for unobservable asset stocks, however, we avoided relying on SES outcomes such as income or harvest to measure AC. Although many studies include system outcomes like income as a measure of AC (Yohe and Tol 2002, Adger et al. 2004), we find that approach problematic because the outcomes could be sensitive to changes in the drivers and therefore not helpful for reducing vulnerability.

We applied a two-step process for selecting indicators in each of the domains. First, we identified appropriate indicators that were consistent with theory and literature on AC, as it would apply to the North Slope context. Application to North Slope communities was grounded in the authors' knowledge of the region from many years of studies working with individual communities (Kruse et al. 2004, BurnSilver et al. 2016, Kofinas et al. 2016b, Berman et al. 2017). Then we selected specific measures of these indicators based on availability of recent information for all the NS communities, and on measurable community differences. Applying these criteria to the data available for Alaska NS communities, we selected 28 measures of

Fig. 3. Normalized rank scores and total rank of adaptive capacity (AC) among eight North Slope communities: average ranking across all measures in each domain and sum of rankings (total score) across all domains: 1 = highest, 8 = lowest.

	Physical geography	Ecosystem health	Physical infrastructure	Human capital	Social and cultural capital	Financial capital	Institutional capital	Total score
Anaktuvuk Pass	2.2	5.3	4.2	6.7	3.8	4.7	4.7	31.8
Atqasuk	3.8	5.0	3.2	5.7	5.6	5.3	1.7	30.2
Kaktovik	3.0	4.7	3.0	2.0	4.0	3.0	2.0	21.7
Nuiqsut	3.0	5.7	2.3	6.7	2.8	1.3	2.3	24.1
Point Hope	4.0	1.7	3.5	4.0	4.0	3.0	3.0	23.2
Point Lay	5.8	2.0	5.2	5.7	5.2	5.0	3.0	31.8
Utqiaġvik	1.4	3.3	1.3	2.0	3.6	2.3	3.3	17.3
Wainwright	4.4	3.3	4.0	3.0	4.0	3.0	4.0	25.7

Color key from rank order: 1 2 3 4 5 6 7 8

22 indicators to assess AC in the seven domains (Table 1). We used the best available data, acknowledging that incomplete or poor-quality data limited the precision of comparisons for some measures. Appendix 1 provides definitions and data sources for all indicators. The literature provides little guidance for determining relative importance of AC domains, and each measure has different units and associated scale. We ranked communities on each measure and constructed measures of comparative AC for each domain based on the average rank of that community across all measures in that domain. An index of overall community AC was then derived by adding up the normalized scores within each domain, assuming each domain was equally important. Appendix 2 provides links to an online data repository that contains the data and detailed methods used to calculate the scoring and ranking of AC within and among the seven domains. The grouping of indicators into domains is inherently somewhat arbitrary: we noted above how different authors grouped similar indicators differently. In addition, legitimate concerns may be raised about the quality of the data available for certain of the indicators. We addressed these concerns by conducting three sensitivity analyses (Appendix 3) that evaluate how aggregation or separation of indicators into domains and data quality issues might affect the consistency of community rankings.

RESULTS

Measures and community comparisons

Figure 3 shows the average ranking of North Slope communities based on a set of measures for each AC domain, as well as an overall rank based on the sum of rankings across all domains. The rank order of communities differs for each of the seven domains. However, some communities consistently ranked higher than others across multiple domains. The total scores formed by summing the average rank scores for each domain ranged from 17 to 32. Utqiaġvik, the highest ranked community (lowest total score), never ranked below third place in any domain. Point Lay, the lowest ranked community (highest total score), ranked seventh or eighth in five of the seven domains. The sensitivity analysis indicated that reorganizing indicators to represent domains of AC as defined in other studies did change the ranking of communities in some cases, as did adding the requirement that measured differences among communities had to exceed a margin error to break ties. However, the communities could be grouped into three tiers that were robust to all specifications. Utqiaġvik remained the top-ranked community in all variations (total score < 20), followed by a group of communities with moderate AC that included Kaktovik, Point Hope, Nuiqsut, and Wainwright (total score 20–30). A third group, with the lowest AC (total score > 30), included Point Lay, Atqasuk, and Anaktuvuk Pass. Appendix 3 provides the details of sensitivity analyses conducted and the effects on community rankings.

Within each domain, some highlights serve to illustrate similarities and differences among NS communities that combine to generate the overall scores.

Physical geography/remoteness

Remoteness raises shipping costs and impedes mobility. We measured remoteness through a variety of measures of air travel and seasonal ice road access to the most affordable urban center containing a full range of consumer and business services (Fairbanks or Anchorage). Utqiaġvik had the lowest fares and best air access, with multiple daily jet flights by a major carrier. Travel to Point Lay is the costliest and least convenient.

Ecosystem health

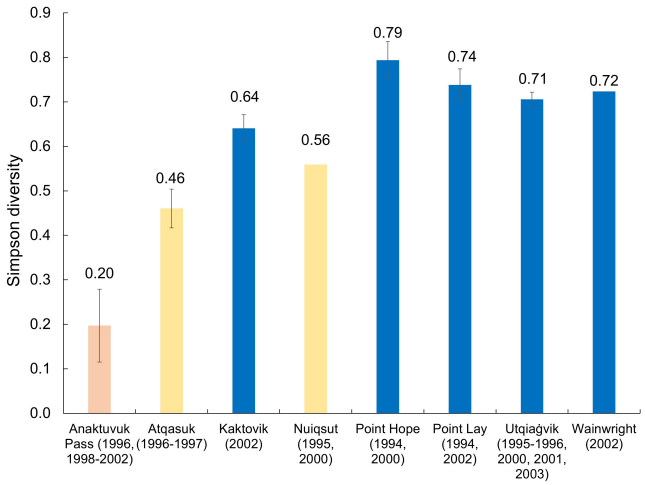
Diversity of subsistence harvests improves food security by reducing dependence on any one potentially uncertain resource. To assess harvest diversity, we calculated the average annual Simpson's diversity index (Simpson 1949) using total pounds harvested for 11 major subsistence species groups (Fig. 4). Because of the importance of subsistence bowhead (*Balaena mysticetus*) whaling to the Iñupiat, we also considered whaling opportunities measured by the number of harvest seasons. We assessed potential ecosystem disturbance with a categorical measure of nearby oil and gas activities. Residents of coastal whaling communities distant from oil and gas activities, Point Hope and Point Lay, scored highest for this domain. Although located somewhat inland, Nuiqsut residents participate in fall whaling and other coastal subsistence activities. However, the community is heavily affected by oil development, causing concern among residents about its effects on subsistence resources and ecosystem health (DeMarban 2017).

Physical infrastructure

The quality of community infrastructure affects quality of life and multiple community goals. Housing shortages beset many NS communities, but the degree varies, with Utqiaġvik least

overcrowded (20% living with > 1 person per room) and Point Lay the most overcrowded (49%). Although Nuiqsut is overcrowded (43%), it has the least problems with housing affordability. Utqiaġvik, Nuiqsut, Point Hope, and Wainwright have faster internet service, which is important in today's connected world, delivered via fiber optic cable versus satellite service as available in other NS communities (ASTAC 2018). Utqiaġvik is the only community with a local hospital and jail.

Fig. 4. Average annual Simpson's Diversity Index for subsistence harvest species in North Slope communities. Survey years are enclosed in parentheses. Blue bars represent coastal communities, yellow bars communities near the coast, and orange bars inland communities. Error bars represent standard deviations. Source: Bacon et al. 2009.



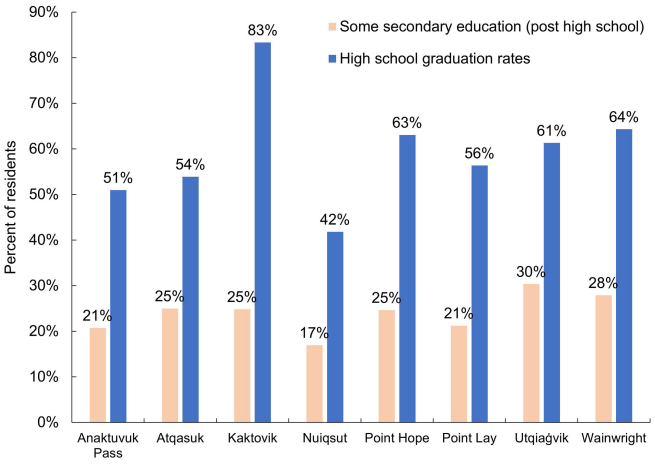
Human capital

We used high school graduation rates, the percentage of residents with post-secondary education, and standardized test performance to assess human capital. Utqiaġvik had the largest percentage of residents with post-secondary education (Fig. 5). However, graduation rates and standardized test scores, i.e., investment in human capital, were highest in Kaktovik. Traditional knowledge (TK) represents another type of human capital, but difficult to measure. We include investment in TK and other cultural assets in social and cultural capital.

Social and cultural capital

We measured several indicators of investment in social and cultural capital, including wild-food sharing within and outside the community, participation in harvesting and tool-making activities, use of the Indigenous language at home, and number of whaling crews. Sharing networks connect households throughout the NS, helping to buffer fluctuations in harvest success (Bacon et al. 2009, BurnSilver et al. 2016). Broad participation in harvesting activities builds skills and TK, and activities such as sewing and boat making help pass along cultural knowledge (Thornton 2011). Larsen et al. (2014) included language retention as an indicator of control over knowledge construction, as well as an indicator of cultural vitality. Nuiqsut had the largest percentage of households (HH) engaging in subsistence activities, i.e., hunting, fishing, sled making, etc., and scored moderately high in all other categories. Kaktovik had the most whaling captains (crews) per capita, followed by Utqiaġvik and Point Hope. Iñupiaq language was used in at least half of Iñupiat households in Utqiaġvik and Wainwright, but in less than a quarter of HH in Kaktovik and Point Hope.

Fig. 5. Percentage of residents 25 and older with education beyond high school (2009-2017), and high-school graduation rates. Sources: Alaska Department of Education and Early Development: https://education.alaska.gov/data-center; American Community Survey, https://data.census.gov/cedsci/, TableID: C15002C.



Financial capital

Oil development at Prudhoe Bay and on adjacent lands supports the robust cash economy of all NS communities. The NSB collects property taxes on oil and gas infrastructure ($386 million in 2016 [Alaska Division of Community and Regional Affairs 2017]) that it uses to create jobs for residents as well as provide services (Knapp and Morehouse 1991, Bell 2016). Most NSB residents also receive dividends from the Alaska Permanent Fund (Berman 2018), the state's sovereign wealth fund, as well as from ASRC, the regional corporation established under the Alaska Native Claims Settlement Act (ANCSA), all derived mostly from oil development. Given that NSB communities showed no systematic differences in access to these funds, we relied on other indicators to assess financial capital: diversity of the cash economy (percentage of employment in local government, negatively ranked), ANCSA village corporation dividends ($ per share), and presence of a commercial bank office in the community. Government employment may be a source of stability in some regions, such as the Canadian Arctic; however, on the North Slope it is predominantly local government (North Slope Borough), which depends almost entirely on local oil and gas activity. Employment in local government was the lowest in Nuiqsut (51%) and much higher in Point Lay (76%), Atqasuk (84%), and Anaktuvuk Pass (72%). Nuiqsut also had by far the largest village corporation dividends (> $20 per share). Utqiaġvik is the only community with a bank that might provide loans to local small businesses.

Institutional capital

Institutions are a key determinant of SES stability and change (Herrfahrdt-Pähle and Pahl-Wostl 2012). NSB residents and communities are embedded in a complex web of formal and informal institutions at multiple scales that affect almost every other domain of AC. Appendix 4 lists the important local, regional, and national formal institutions, along with the role each plays. For assessing differences in community institutional capacity, we focused only on formal institutions. The presence of a state-recognized city government in addition to the federally recognized tribal government, and the number of seats on state and federal subsistence management boards, represented cross-scale governance capacity. The number of local police officers per person during a shift indicated emergent response capacity. Point Lay is the only community that lacks an incorporated city government but is tied with Atqasuk for the most NSB police officers per person. Utqiaġvik, being a larger community, had the most representatives on subsistence boards but the fewest police officers per capita.

DISCUSSION

Assessing AC of Arctic communities is an important priority for research on responding to climate and other forces for change (Petrov et al. 2016, Carson et al. 2017). Empirically based measures of adaptive capacity provide information to help community residents and policy makers at all levels determine the short- and long-term allocation of resources for setting resilience pathways (IPCC 2019:271-273). They can also help prepare communities to engage in participatory scenario analysis for the unforeseen consequences of rapid change. Such measures can also contribute to Arctic-wide efforts to establish indicator programs for human well-being (Larson 2010).

Research that compares AC across communities within a consistent generalized framework, however, is limited (Berman et al. 2017, Carson et al. 2017). We used available data to construct indicators and compare AC among NS Alaska communities as it bears on vulnerability and resilience to climate and land use change along with other co-occurring drivers.

Our review of these indicators shows that there are notable differences in AC assets that could affect future vulnerability. Utqiaġvik has by far the most physical and social infrastructure among NS communities. Subsistence is strong in all communities, but Utqiaġvik has several advantages, including participating in both fall and spring whaling, as well as more whaling crews per capita. Utqiaġvik is also the headquarters of the NSB and the ASRC, along with the associated jobs at those headquarters. Utqiaġvik is of course somewhat of a special case, being substantially larger than any of the other communities. However, it is far from certain whether the size is a cause of the greater AC or an effect. The federal and also later the state government designated Utqiaġvik as the administrative center for the region decades ago. The centralized provision of services and associated infrastructure in such rural Alaska regional centers gave them employment opportunities as well as enhanced AC that attracted migrants from surrounding communities (Howe et al. 2014). The increasing share of population residing in larger settlements is a common pattern across the Arctic (Heleniak 2015).

Assessing the effect of the varying levels of AC on observed vulnerability and resilience outcomes in the communities is difficult, because the drivers differ by community. Nuiqsut in particular has been affected profoundly by oil development in the area. However, oil development has brought substantial benefits in the form of jobs, dividends, access (reduced remoteness), and reduced living costs at the same time as the environment has become somewhat degraded. Regional environmental change due to climate warming is projected to accelerate in the future, but ongoing adaptation strategies supported by the various AC components have so far been sufficient to sustain well-being outcomes in all NSB communities. Future climate change, interacting with plausible scenarios for other drivers (e.g., land-use and economic change), however, could pose challenges beyond what residents have experienced in the past. The winding down of oil development on the North Slope could lead to difficult adjustments, particularly for Nuiqsut, which could experience local ecological degradation as well as a loss of employment and income.

The community comparison of indicators also suggests opportunities where targeted investments could address observed weaknesses in AC. Kaktovik, which has not yet experienced local oil development impacts but could if leasing occurs in the surrounding Arctic National Wildlife Refuge, has much higher educational attainment than Nuiqsut. Improving high school outcomes in Nuiqsut, which had the lowest educational attainment among NS communities, could help the community adapt.

Although the indicators suggest that Utqiaġvik has greater AC than other communities in the region, smaller communities may enjoy more subtle advantages that are more difficult to measure. For example, smaller communities may have a different quality of social capital that could be helpful in being more responsive and achieving the consensus needed to translate adaptation plans into action. It is difficult to determine a pattern or typology that can explain the difference between the two groups of smaller communities with greater and lesser AC. One characteristic they all have in common is that they are coastal communities or have access to marine subsistence resources. Access to coastal resources provides more ecological diversity, which could make their subsistence harvests more robust to oil development effects. Inland communities like Anaktuvuk Pass and Atqasuk may be able to utilize sharing networks with other communities to compensate for a less diverse pool of subsistence resources. Nuiqsut has the advantage of wealth to "compensate" for lower ecosystem health.

Institutions, especially the NSB, play a major role in all domains of AC in all study communities. In addition to providing infrastructure, public services, and employment, the NSB offers wildlife-management services that support other local institutions such as co-management organizations and advisory boards that share governance with state, national, and international agencies. The overwhelming importance of the North Slope Borough in providing AC to NS communities makes the NS region in many ways a special case. It is therefore difficult to compare AC in the region to AC in communities in other rural Alaska regions or to communities in other Arctic nations. Ability to tax extensive local oil infrastructure give the NSB the financial capacity to provide services that other Arctic local governments cannot provide.

Although institutions are clearly important for NSB communities, empirical evidence is limited regarding whether and how some AC assets may be more important than others in

different contexts. Knowledge of how individual AC domains may interact to generate overall community AC is also limited. Furthermore, community-level AC is embedded within a panarchy of SES interactions (Chaffin and Gunderson 2016), influenced by household AC and AC at larger scales. Although systematic identification of indicators of AC is best undertaken through a process of knowledge co-production with local communities, managers, and researchers (Carson et al. 2017), this was not a feasible option in this study with such a large set of communities, although the authors did participate in knowledge co-production studies related to AC in three of the communities (Kofinas et al. 2016b, Berman et al. 2017). Lack of community-level data limits what indicators can be measured, and may pose an even bigger challenge than community participation for comparative empirical studies.

CONCLUSION

We identified and compared measures of 22 indicators of adaptive capacity to environmental change, based on consistency with theory, availability of data, and measurable community differences for the eight communities of Alaska's North Slope. Despite many cultural and institutional similarities among the communities, whose largely Iñupiat population continues to practice a mixed subsistence–cash economy, we found differences among communities for each of the seven AC domains measured. Although every community had strengths in some domains, we could divide communities into three groups with high overall AC (one community), moderate overall AC (four communities), and low overall AC (three communities), based on average rank order across all domains. We also confirmed findings of others regarding the importance of local institutions to adaptive capacity.

We note that identifying empirical patterns that may be useful for policy and transferable to other places requires careful definition and measurement of adaptive capacity. Our analysis suggests that measurable indicators of AC such as those compiled here can increase understanding of the barriers and facilitating conditions for responding to climate and other changes, despite data limitations. Future research into how various domains interact and better methods for pairing empirically measurable indicators of AC with qualitative case studies of adaptation would provide a richer understanding and improved application to policy making. Studies that retrospectively compare and prospectively assess AC of NSB communities to other Arctic communities could advance a theory of AC and further elucidate opportunities for informing adaption.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/12304

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Data Availability:

The data/code that support the findings of this study are openly available in Open Science Framework at https://osf.io/gzk4f/ or DOI https://doi.org/10.17605/OSF.IO/GZK4F.

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Appendix 1. Data sources used to assess adaptive capacity among Alaska North Slope communities.

Adaptive capacity domain	Indicator	Measure	Units	Data source
Physical geography	Remoteness	Cost of commercial flight to urban area	$ per person, round trip	1
	Remoteness	Scheduled air travel time to urban center	Minutes, round trip	1
	Remoteness	Air service quality to urban center, round trip	Number of flight segments, round trip	1
	Remoteness	Daily jet service to community	Y/N	2
	Remoteness	Ice road link to road system	Y/N	2
Ecosystem health	Ecological diversity	Harvest diversity, main subsistence foods (Simpson diversity index)	0 (no diversity) to 1 (infinite diversity)	3
	Development disturbance	Oil and gas activities near community	Development, exploration, none	4
	Harvesting opportunities	Number of whaling seasons annually with a harvest	none, spring or fall, spring and fall	5
Physical infrastructure	Housing quality	Crowded housing conditions	% households living with > 1 person/room	6
	Housing quality	Drinking water and sanitation	% of households with complete plumbing	6
	Housing cost	Housing cost as percentage of household income	% spending > 40% of income for housing	6

Adaptive capacity domain	Indicator	Measure	Units	Data source
	Telecommunications access	Fiber optic cable to community	Y/N	7
	Health care facilities	Hospital in community	Y/N	2
	Public safety facilities	Jail in community	Y/N	8
Human capital	Educational attainment	Any secondary education (post high school), Alaska Native people	% persons age 25 and older, 2005-2017	6
	Educational investment	High school graduation	% graduating within 5 years, 2009-2017	9
	Education investment	Proficiency on standardized reading, writing, math, and science academic achievement tests	Ave.% proficient, 2009-2013	9
Social and cultural capital	Investment in social capital	Sharing of subsistence foods among households	% HHs sharing within + % sharing outside community	10
	Investment in cultural capital	Participation in subsistence harvesting activities	% HHs hunting + % fishing	10
	Investment in cultural capital	Investment in production of subsistence cultural assets	% HHs making sleds, boats, or clothes	10
	Social and cultural capital	Whaling crews organized in the community	Whaling captains per 1000 Iñupiat pop.	11
	Access to Indigenous knowledge	Mostly Iñupiat or both Iñupiat and English spoken at home	% of Iñupiaq households, 2015	10

Adaptive capacity domain	Indicator	Measure	Units	Data source
Financial capital	Diversity of cash economy	Percent employment in local government	Local gov't jobs as % of all jobs, 2001-2014	12
	Local business strength	Village corporation dividend paid in recent years	<$2, $2-9, $10-20, >$20 per share	13
	Access to capital	Commercial bank office in community	Y/N	2
Institutional capital	Formal local government	City government incorporated under state law	Y/N	2
	Cross-scale governance	Representation on subsistence co-management boards	State plus federal board representatives	14
	Public safety response	Local police officers stationed in community	Number of police officers	8

Data sources

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Appendix 2. Data and methods used to assess adaptive capacity among North Slope communities. This file is openly available online with the formulas used to calculate ranks (Web Table 2) at Open Science Framework at https://osf.io/gzk4f/, reference number DOI 10.17605/OSF.IO/GZK4F. HH = household. 1 = highest, 8 = lowest.

Color key from rank order: 1 2 3 4 5 6 7 8

Table A2.1 Geography – data

	Minimum cost of round-trip commercial flight to urban area	Minimum time to urban center, minutes	Minimum # of flight segments to urban center, round trip	Daily jet service (Y/N)	Ice road link to road system (Y/N)
Anaktuvuk Pass	$383	200	2.0	No	No
Atqasuk	$673	695	2.0	No	Yes (3rd)
Kaktovik	$473	500	2.0	No	No
Nuiqsut	$924	420	2.0	No	Yes (closest)
Point Hope	$710	555	2.0	No	No
Point Lay	$936	730	1.5	No	No
Utqiaġvik	$230	300	3.0	Yes	Yes (2nd)
Wainwright	$669	515	1.5	No	No

Table A2.2 Geography – rank

	Cost to nearest urban area	Travel time (Dept to arrival, shortest)	# of flights to get to and from an urban center	Jet	Ice Road to Urban (Y/N)
Anaktuvuk Pass	2	1	2	2	4
Atqasuk	5	7	2	2	3
Kaktovik	3	4	2	2	4
Nuiqsut	7	3	2	2	1
Point Hope	6	6	2	2	4
Point Lay	8	8	7	2	4

Utqiaġvik	1	2	1	1	2
Wainwright	4	5	7	2	4

Table A2.3 Ecosystems – data

		Harvest diversity (Simpson diversity index)	Oil and Gas Activities near community in 2019	Number of bowhead harvest seasons with a harvest
Ecosystems	Anaktuvuk Pass	0.20	None	0
Ecosystems	Atqasuk	0.46	None	0
Ecosystems	Kaktovik	0.64	Exploration	1
Ecosystems	Nuiqsut	0.56	Development	1
Ecosystems	Point Hope	0.79	None	1
Ecosystems	Point Lay	0.74	None	1
Ecosystems	Utqiaġvik	0.71	Limited	2
Ecosystems	Wainwright	0.72	Exploration	2

Table A2.4 Ecosystems – data

	Harvest diversity (Simpson diversity index)	Oil and Gas Activities near community in 2019	Number of bowhead harvest seasons with a harvest
Anaktuvuk Pass	8	1	7
Atqasuk	7	1	7
Kaktovik	5	6	3
Nuiqsut	6	8	3
Point Hope	1	1	3
Point Lay	2	1	3
Utqiaġvik	4	5	1
Wainwright	3	6	1

Table A2.5 Physical infrastructure – data

	Overcrowding (more than 1 people per room)	% of households that use > 40% of income for housing	Fiber optic cable	% of HH with pluming	Hospital	Jail
Anaktuvuk Pass	32%	12%	No	86%	No	No
Atqasuk	29%	7%	No	86%	No	No
Kaktovik	22%	9%	No	92%	No	No
Nuiqsut	45%	1%	Yes	95%	No	No
Point Hope	37%	8%	Yes	83%	No	No
Point Lay	47%	9%	No	57%	No	No
Utqiaġvik	21%	5%	Yes	92%	Yes	Yes
Wainwright	33%	9%	Yes	79%	No	No

Table A2.6 Physical infrastructure – rank

	Overcrowding (more than 1 people per room)	% of households that use > 40% of income for housing	Fiber optic cable	% of HH with pluming	Hospital	Jail
Anaktuvuk Pass	4	8	5	4	2	2
Atqasuk	3	3	5	4	2	2
Kaktovik	2	5	5	2	2	2
Nuiqsut	7	1	1	1	2	2
Point Hope	6	4	1	6	2	2
Point Lay	8	5	5	8	2	2
Utqiaġvik	1	2	1	2	1	1
Wainwright	5	5	1	7	2	2

Table A2.7 Human capital – data

	Some secondary education (post high school) (2009-2017)	Graduation Rates (2009-2017)	Average percent of students proficient on academic achievement tests (2009-2013)
Anaktuvuk Pass	21%	49%	24%
Atqasuk	25%	49%	19%
Kaktovik	25%	84%	44%
Nuiqsut	17%	36%	32%
Point Hope	25%	62%	26%
Point Lay	21%	55%	25%
Utqiaġvik	30%	60%	38%
Wainwright	28%	57%	37%

Table A2.8 Human capital – rank

	Some secondary education (post high school) (2009-2017)	Graduation Rates (2009-2017)	Average percent of students proficient on academic achievement tests
Anaktuvuk Pass	6	6	7
Atqasuk	3	6	8
Kaktovik	3	1	1
Nuiqsut	8	8	4
Point Hope	3	2	5
Point Lay	6	5	6
Utqiaġvik	1	3	2
Wainwright	2	4	3

Table A2.9 Social and cultural capital – data

	Sum of the percent of households sharing within and outside the community, rounded	Percent of HH that hunt and fish, rounded	Make sleds, boats, or clothes	Per capita bowhead whale captains (# captains/population) * 1000	Mostly Iñupiat or both Iñupiat and English spoken in Iñupiaq households (2015)
Anaktuvuk Pass	150%	105%	18%	0	48%
Atqasuk	150%	95%	7%	0	43%
Kaktovik	150%	120%	16%	39	22%
Nuiqsut	160%	120%	28%	15	47%
Point Hope	180%	75%	18%	20	20%
Point Lay	170%	80%	12%	9	26%
Utqiaġvik	150%	70%	17%	21	60%
Wainwright	150%	80%	13%	17	50%

Table A2.10 Social and cultural capital – rank

	Sum of the percent of households sharing within and outside the community	Percent of HH that hunt and fish	Make sleds, boats, or clothes	Per capita bowhead whale captains (# captains/population) * 1000	Mostly Iñupiat or both Iñupiat and English spoken in Iñupiaq households (2015)
Anaktuvuk Pass	4	3	2	7	3
Atqasuk	4	4	8	7	5
Kaktovik	4	1	5	1	7
Nuiqsut	3	1	1	5	4
Point Hope	1	7	2	3	8
Point Lay	2	5	7	6	6
Utqiaġvik	4	8	4	2	1

Wainwright	4	5	6	4	2

Table A2.11 Financial capital – data

	Percent employment in local government (2001-2014)	Village corporation dividend ($ per share)	Bank present
Anaktuvuk Pass	72%	<$2	No
Atqasuk	84%	<$2	No
Kaktovik	59%	$2-$10	No
Nuiqsut	51%	>$20	No
Point Hope	58%	$2-$10	No
Point Lay	76%	<$2	No
Utqiaġvik	55%	$2-$10	Yes
Wainwright	60%	$10-$20	No

Table A2.12 Financial capital – rank

	Percent local gov.	Village corporation dividend ($ per share)	Bank present
Anaktuvuk Pass	6	6	2
Atqasuk	8	6	2
Kaktovik	4	3	2
Nuiqsut	1	1	2
Point Hope	3	4	2
Point Lay	7	6	2
Utqiaġvik	2	4	1
Wainwright	5	2	2

Table A2.13 Institutional capital – data

	City government	Total seats on subsistence boards	Local police officers
Anaktuvuk Pass	Yes	1	1
Atqasuk	Yes	2	1
Kaktovik	Yes	2	1
Nuiqsut	Yes	2	2
Point Hope	Yes	2	2
Point Lay	No	1	1
Utqiaġvik	Yes	7	8
Wainwright	Yes	1	2

Table A2.14 Institutional capital – data

	City government	Representation on subsistence boards	Local police officers
Anaktuvuk Pass	1	6	5
Atqasuk	1	2	5
Kaktovik	1	2	5
Nuiqsut	1	2	2
Point Hope	1	2	2
Point Lay	2	6	5
Utqiaġvik	1	1	1
Wainwright	1	6	2

Appendix 3. Sensitivity analysis of metrics used to assess adaptive capacity among North Slope communities. This file is available online (Web Table 3). These are openly available at Open Science Framework at https://osf.io/gzk4f/, reference number DOI 10.17605/OSF.IO/GZK4F.

Table A3.1 Original framing, indicator averages.

	Geography	Ecosystems	Physical Infrastructure	Human Capital	Social and Cultural Capital	Financial Capital	Institutional Capital	Total score	Rank	General group
Anaktuvuk Pass	2.2	5.3	4.2	6.7	3.8	4.7	4.0	30.8	6th	3
Atqasuk	3.8	5.0	3.2	5.7	5.6	5.3	2.7	31.2	7th	3
Kaktovik	3.0	4.7	3.0	2.0	3.6	3.0	2.7	21.9	2nd	2
Nuiqsut	3.0	5.7	2.3	6.7	2.8	1.3	1.7	23.5	4th	2
Point Hope	4.0	1.7	3.5	4.0	4.2	3.0	1.7	22.0	3rd	2
Point Lay	5.8	2.0	5.2	5.7	5.2	5.0	4.3	33.2	8th	3
Utqiaġvik	1.4	3.3	1.3	2.0	3.8	2.3	1.0	15.2	1st	1
Wainwright	4.4	3.3	3.7	3.0	4.2	3.0	3.0	24.6	5th	2

Table A3.2 Sensitivity framing, indicator averages.

	Geography	Ecosystems	Physical Infrastructure	Human Capital	Social and Cultural Capital	Financial Capital	Institutional Capital	Total score	Rank	Original rank	General group	Original general group
Anaktuvuk Pass	2.2	5.3	4.2	7.0	3.8	3.0	4.0	29.5	6th	6th	3	3
Atqasuk	3.8	5.0	3.2	5.7	5.8	3.7	2.7	29.8	7th	7th	3	3
Kaktovik	3.0	4.7	2.8	2.0	4.2	4.0	2.7	23.4	3rd	2nd	2	2
Nuiqsut	3.0	5.7	2.3	6.7	3.0	1.3	1.7	23.7	4th	4th	2	2
Point Hope	4.0	1.7	3.2	4.0	4.4	3.7	1.7	22.6	2nd	3rd	2	2
Point Lay	5.8	2.0	5.0	5.7	5.4	3.3	4.3	31.5	8th	8th	3	3
Utqiaġvik	1.4	3.3	1.2	2.0	4.2	3.0	1.0	16.1	1st	1st	1	1
Wainwright	4.4	3.3	3.7	3.0	5.0	4.0	3.0	26.4	5th	5th	2	2

Table A3.3 Sensitivity framing, sum of domain ranks.

	Geography	Ecosystems	Physical Infrastructure	Human Capital	Social and Cultural Capital	Financial Capital	Institutional Capital	Total score	Rank	Original rank	General group	Original general group
Anaktuvuk Pass	2	7	7	8	2	2	7	35	5th	6th	3	3
Atqasuk	5	6	4	5	8	5	4	37	6th	7th	3	3
Kaktovik	3	5	3	1	3	7	4	26	3rd	3rd	2	2
Nuiqsut	3	8	2	7	1	1	2	24	2nd	2nd	2	2
Point Hope	6	1	4	4	5	5	2	27	4th	4th	2	2
Point Lay	8	2	8	5	7	4	8	42	8th	8th	3	3
Utqiaġvik	1	3	1	1	3	2	1	12	1st	1st	1	1
Wainwright	7	3	6	3	6	7	6	38	7th	5th	2	2

Table A3.4 Sensitivity analysis.

	Average of social and cultural and institutional	Total score	Sum of social and cultural and institutional indicators/8	Total score	Original rank
Anaktuvuk Pass	5.8	36.8	3.9	34.9	6th
Atqasuk	6.9	35.2	4.5	32.8	7th
Kaktovik	4.9	25.9	3.3	24.3	2nd
Nuiqsut	3.6	26.0	2.4	24.7	4th
Point Hope	5.0	24.5	3.3	22.8	3rd
Point Lay	7.4	39.7	4.9	37.2	8th
Utqiaġvik	4.3	16.7	2.8	15.2	1st
Wainwright	5.7	29.1	3.8	27.2	5th

Appendix 4. Institutions and Adaptive Capacity for Alaska North Slope Communities[a]

Adaptive Capacity domain	Category	Institutions playing a major role
Geography	Remoteness	US DOT (jet service subsidies), USPS (bypass mail)
Ecosystems	Ecosystem health - terrestrial	ADF&G, NSB Wildlife Management Dept., NPS, USFWS
	Ecosystem health - marine	NOAA, NSB Wildlife Management Dept, co-management boards
	Resource protection	NSB Wildlife Management Dept., BLM, subsistence advisory boards, NPS, USFWS, Eskimo Whaling Commission
Physical infrastructure	Housing quality	AHFC, NSB Planning Dept.
	Water-sewer system	NSB utilities, ANTHC, Alaska DCRD, EPA
	Transportation system	NSB Dept. of Public Works
	Tele-communications	Internet service providers, FCC
Human capital	Formal education	NSB School District
	Health care	AKHSS, Alaska Native Corporations
	Traditional knowledge	NSB School District Iñupiat Education Dept.
Social and cultural capital	Social Ties	Informal sharing networks, whaling crews
	Language retention	NSB School District Iñupiat Education Dept.
	Public safety	NSB Police, Fire, Search and Rescue
Cash economy	Wage employment opportunities	NSB, village corps., ASRC
	Diversity of employment opportunities	Public, private, and government entities
	Non-wage income	ASRC, village corps., Alaska PF
	Local government spending capacity	Oil companies, village corporations, ASRC

[a] Table abbreviations:

Abbreviation	Name	Activities
ADCRD	Alaska Division of Community and Regional Development	Water and sewer infrastructure grants and services
ADFG	Alaska Department of Fish and Game	Fish and wildlife management
ADPH	Alaska Division of Public Health	Alaska state public health programs
AEWC	Alaska Eskimo Whaling Commission	Co-management of subsistence whaling
ANTHC	Alaska Native Tribal Health Consortium	Water and sewer infrastructure grants and services
ASNA	Arctic Slope Native Association	Tribal health and social service provider
ASRC	Arctic Slope Regional Corporation	For-profit regional native corporation, oil land manager
BLM	US Bureau of Land Management	Federal land management, onshore oil leasing
BOEM	US Bureau of Ocean Energy Management	Federal offshore oil leasing
DOT	US Dept. of Transportation	Air service subsidies
EPA	US Environmental Protection Agency	Water and sewer infrastructure grants, resource protection
FCC	US Federal Communications Commission	Access to broadband tele-communications services
FWS	US Fish and Wildlife Service	Fish and wildlife management
NOAA	National Oceanic and Atmospheric Service	Marine mammal management
NPS	US National Park Service	Land management for federal protected areas
NSB	North Slope Borough	Full range of public services
PFD	Permanent Fund Dividend	Universal basic income from the Alaska Permanent Fund
USPS	US Postal Service	Subsidized mail and freight delivery