BROOKINGS-LSE
Project on Internal Displacement

Climate-Induced Displacement of Alaska Native Communities

January 30, 2013

Robin Bronen
Alaskan Immigration Justice Project

Cover image: Winifried K. Dallmann, Norwegian Polar Institute.
http://www.arctic-council.org/index.php/en/about/maps.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Alaska has warmed twice as fast as the global average during the past half-century, and temperatures are projected to rise 1.5-5° F (1-3 ºC) by 2030 and by 5-18° F (3-6.5 ºC) by 2100. Less sea ice covers the Arctic Ocean today than at any time in recent geologic history. At the same time, the land itself is also affected by temperature increases. Permanently frozen subsoil – permafrost – keeps the land intact and habitable along the northwestern Alaskan coast, but is melting. These environmental phenomena are resulting in accelerated rates of erosion and flooding which damage or destroy infrastructure and threaten the livelihoods and well-being of people residing throughout Alaska. Since 2003, federal and state governments have documented these climate change impacts on Alaskan communities and the need for immediate action to protect populations. State and federal government agencies are struggling to respond to the enormous new needs of these communities. Despite spending millions of dollars, the traditional methods of erosion control and flood protection have not been able to protect some communities. For several Alaska Native communities, protection in place is not possible and community relocation is the only adaptation strategy that can protect them from accelerating climate change impacts. This paper presents a brief overview of climate change in Alaska, examines the impact of climate change on Alaska Native rural villages, and analyzes the state, federal and community responses. Outlined below are highlights from the full report, which can be consulted for further information and analysis.

Overview of Climate Change Effects

Flooding and erosion threaten the habitability of a significant number of Alaska Native communities. Rapid climactic changes are occurring faster than many of the climate models predicted, affect the totality of the environment where humans exist in Alaska, and present Alaska Native communities with unprecedented challenges to adapt (Markon 2012). Historically, the ancestors of the current residents of Alaska Native communities migrated seasonally among several coastal and inland hunting and fishing camps in order to follow the wild game and fish on which they depended for their survival (ANTHC 2011; Berardi 1999; Schweitzer et al. 2005; USACE 2008b, Marino 2012). The Alaska Native population consolidated into permanent settlements primarily because of the requirement by the U.S. Department of the Interior's Bureau of Education that Alaska Native children attend school (Berardi 1999; Darnell 1979; USACE 2008b, Marino, 2012), the location of which was determined by barge accessibility to transport construction materials (USACE 2008b). The building of schools and sewage, water, and electricity infrastructure led to a change from seasonal migration to the establishment of permanent communities at school sites selected by the federal government. The below climactic changes are among those that Alaska Native communities face.

- **Decreasing Arctic sea ice extent and warmer temperatures are having detrimental effects on many Alaska Native coastal communities,** exposing many to the flooding and erosion caused by storms that originate in the Bering and Chukchi Seas and occur primarily between August and early December (Shulski andWendler 2007, Hufford and Partain 2005, ASCG 2008).
- **Permafrost, which keeps the land intact and habitable along the northwestern Alaskan coast, is melting** due to temperature increases, causing infrastructure, including

water and sewage systems, to sink into the earth and alters their structural integrity (GAO 2009, Serreze 2008).

- **Erosion, accelerated by decreased sea ice extent and thawing permafrost, is leading Alaska Native villages to seek relocation of their communities.** Historically, communities could move away from areas affected by erosion because they did not depend on built infrastructure. However, the construction of public facilities such as power plants, schools, health clinics, and airports, ties communities to the land and limits their ability to move (USACE 2009). Notwithstanding, some communities have sought to relocate their infrastructure to higher ground located close to the original village sites; it is recognized that other communities need to relocate in their entirety because there is no higher ground close to the community and all of the land on which the community is located is exposed to flooding and erosion. This paper examines 12 of the most threatened communities – located in diverse and geographically remote areas in Alaska – which fall under both of these types of relocation strategies (GAO 2009). The phenomenon of erosion facing Alaska Native communities is well-documented. Several communities, including those which are now most threatened by erosion, began documenting the impact of erosion on their community in the 1980s in order to develop a long-term strategy for protection in place (Cox 2007). In addition, during this same period of time, the State of Alaska documented the impact of erosion on communities throughout Alaska (ADOT& PF 1984). More recently, the US Army Corps of Engineers (USACE), the US Government Accountability Office (GAO) and the Alaska Sub-Cabinet on Climate Change Immediate Action Workgroup (IAWG) have each issued numerous reports, documenting the increasing severity of erosion on Alaska Native villages. These reports have used diverse methodologies to assess and prioritize the harm to these communities in order to inspire immediate action. The reports have also evaluated the past efforts to protect communities in place and the cost of future protection for threatened communities, including the cost and viability of community relocation (GAO 2009, USACE 2009, IAWG 2009, IAWG 2008b, USACE 2006a, GAO 2003).
- **Changes in the abundance and distribution of wildlife and marine life** are predicted to occur due to changing climatic conditions. Changing vegetation patterns will impact the migration patterns of animal and bird life, which will affect the ability of the Alaska Native population to gather their traditional subsistence foods (Kofinas et al. 2010). Warmer temperatures also affect marine mammals that that are dependent on sea ice for their habitat and hunted by Alaska Native peoples, including bowhead whales, beluga whales, ringed seals, bearded seals, walrus, and polar bears (Simpkins 2010), while less arctic sea ice is projected to reduce marine mammal populations (Adaptation Advisory Group 2010).Warmer ocean and stream temperatures may also be a factor in recent declines of salmon stock (Farley et al. 2005, Mundy and Evenson 2011).

Government Response to Climate-Threatened Communities

The paper examines the steps the state government has taken to assess the impacts of climate change, the programs the state has undertaken to address displacement and the remaining challenges to state and federal response.

- In 2007, the State of Alaska recognized the need to develop a statewide strategy to understand and respond to the impact of climate change. Former Alaska Governor Sarah Palin officially formed the Alaska Climate Change Sub-Cabinet (Palin 2007), which established the Immediate Action Workgroup (IAWG) in 2007. The IAWG was a collaborative multidisciplinary and intergovernmental workgroup tasked with the responsibility to identify the immediate needs of communities imminently threatened by the effects of erosion, flooding, permafrost degradation, and other climate change-related impacts (IAWG 2008b). The IAWG last met in March 2011; it failed to receive authorization from Governor Parnell or the Subcabinet on Climate Change to continue its work (IAWG 2011a, IAWG 2011b). No explanation has been given to explain the failure to reauthorize the work of the IAWG.
- The IAWG identified six communities most imperiled by climate change and in need of immediate action (IAWG 2008). All are communities with a majority of Alaska Native residents. The IAWG facilitated numerous meetings with representatives of these communities to develop a strategy to respond to climate-related threats and was instrumental in advancing to the Alaska State Legislature funding recommendations for so that these communities could receive the necessary financial resources to respond to the changing environment. The IAWG also issued two reports outlining several recommendations to respond to the needs of the imperiled communities located along Alaska's coast and rivers (IAWG 2008b, IAWG 2009).
- The State of Alaska has implemented two programs to address the emergent needs of communities faced with displacement. Based on the recommendations of the IAWG, in 2008, the Alaska Legislature established the Alaska Climate Change Impact Mitigation Program (ACCIMP) (3 AAC 195.040). Funding from the ACCIMP is limited to two community categories. Non-competitive funding is allocated to six communities designated by name that are currently threatened by climate-induced ecological change. The remaining funds are administered through a competitive grant process to complete hazard impact assessments will then be eligible for additional funding to support adaptation activities, including relocation planning. The second program is funded through the US Fish and Wildlife Coastal Impact Assistance Program. Using the collaborative model the Alaska Division of Community and Regional Affairs (DCRA) established for the Newtok Planning Group, funding will be used by DCRA project staff to organize inter-agency working groups, which include tribal, local, regional, state, and federal stakeholders for the three communities. These working groups will develop strategic plans that respond to current and future threats to the well-being of community residents and infrastructure endangered by erosion, flooding and storm surge.

Community Relocation and the Challenges of Government Response

Community relocation may be the only adaptation strategy that can protect residents from the damaging effects of flooding and erosion on a significant number of Alaska Native communities. However, a 2009 U.S. Government Accountability Office report recognized that no government agency has the authority to relocate communities, no governmental organization exists that can address the strategic planning needs of relocation, and no funding is specifically designated for relocation (GAO 2009, 24-27). As a result, none of the 12 villages the GAO identified has been able to locate (GAO 2009). The challenges to government response are outlined below.

- There is no adaptive governance framework in place to evaluate when communities and government agencies need to shift their work from protection in place to community relocation.
- The Alaska Climate Change Impact Mitigation Program (ACCIMP) and the Coastal Impact Assistance Program are critical first steps to address the needs of communities facing displacement because of climate change. However, as the GAO (2009) noted, no similar initiative exists at the federal government level.
- Government agencies are spending millions of dollars to construct erosion protection devices which have an anticipated lifespan of ten years (USACE 2007; Bragg 2007a; Bragg 2007b). As government agencies are unable to change their approach from protection in place to relocation, communities are further imperiled. Current federal disaster response legislation, the Stafford Act and its amendments, requires that funding be spent on repairing and rebuilding in the original location of the disaster (Bronen 2011). This means that communities whose location is no longer habitable, or that are located entirely within floodplains, are unable to receive government funding to repair and rebuild damaged infrastructure.
- Funding and institutional issues are also a significant issue for communities that have decided that relocation is their only viable adaptation strategy. State and federal governments have various programs to fund erosion protection, hazard mitigation and disaster relief (USACE 2009, GAO 2009, Bronen 2011). Each of these programs has specific fund requirements and limitations. Communities that decide to relocate are faced with numerous challenges because of the lack of an institutional framework for relocation. For example, without clear guidelines or procedures for choosing a relocation site, two communities, Kivalina and Shishmaref, have voted to relocate to sites that government agencies later determined were unsuitable because of the existence of permafrost. Newtok residents have chosen a relocation site and have started the construction of pioneer infrastructure at the site, but continue to struggle with coordinating the efforts of multiple agencies that have different regulatory and funding criteria. The severity of climate impacts on dozens of Alaskan communities demonstrates the critical need to develop a relocation institutional framework.

To overcome these challenges, the author recommends as a first step that Congress amend disaster relief legislation to enable communities to use existing funding mechanisms to construct infrastructure at relocation sites that are not within the disaster area. The author also recommends that Congress enact legislation to provide a relocation governance framework so that communities have the ability to relocate when the traditional erosion and flood control devices can no longer protect residents in place. In this way, the United States can create a model adaptation strategy that facilitates an effective transition from protection in place to community relocation that governments throughout the world can implement.

INTRODUCTION

In Alaska, winter temperatures have increased 3.5 degrees Celsius since the 1950s, arctic sea ice is decreasing in size and thickness and permafrost is thawing. These environmental phenomena are causing accelerated rates of erosion and flooding, which damage or destroy infrastructure, such as health clinics and schools, and threaten the livelihoods and well-being of people residing throughout Alaska. The federal and state governments have issued numerous reports since 2003 documenting these climate change impacts on Alaskan communities and the need for immediate action to protect populations. In 2003, the US Government Accountability Office (GAO) found that flooding and erosion affect 184 out of 213 of Alaska Native villages, and four of these communities planned to relocate due to these environmental threats. Six years later, the GAO issued a second report and found that erosion and flooding imminently threatened 31 Alaskan communities, and 12 of these communities planned to relocate. State and federal government agencies are struggling to respond to the enormous new needs of these communities. Despite spending millions of dollars, the traditional methods of erosion control and flood protection have been unable to protect some communities. This paper describes the Alaskan experience with these issues. For several Alaska Native communities, protection in place is not possible and community relocation is the only adaptation strategy that can protect them from accelerating climate change impacts.

AN OVERVIEW OF CLIMATE CHANGE IN ALASKA

Throughout Alaska, temperature increases are causing the most severe stresses to the environment (ACIA 2004). During the past half century Alaska has warmed twice as fast as the global average (ACIA 2004, IPCC 2007, USGCRP 2009). Since the 1950s, statewide average temperatures have risen 3.5 degrees Celsius during the winter (ACIA 2004, Shulski and Wendler 2007). According to the US Global Change Research Program, long-range climate models project that Arctic warming will continue. Temperatures are projected to rise 1.5-5° F (1-3 ºC) by 2030 and by 5-18° F (3-6.5 ºC) by 2100 (Parsons et al. 2009).

The decreasing Arctic sea ice extent and thickness are harbingers of the dramatic changes caused by increased temperatures. Satellite images of the Arctic sea ice extent have been recorded since 1979 (Polyak et al. 2010) and provide a useful baseline. Scientific observations of the Arctic sea ice extent during the summer of 2007 documented a new record low, with twenty-three percent less ice coverage measured than the previous record of September 2005, a loss equivalent to the size of California and Texas combined (Polyak et al. 2010). In 2007, scientists believed that the record low was an anomaly and not a signal of fundamental changes in ice dynamics of the Arctic Ocean.

Arctic sea ice extent has continued to set record lows, with the six lowest seasonal minimum ice extents in the satellite record occurring since 2007 (NSIDC 2012a). The National Snow and Ice Data Center documented a new record low in September 2012 (NSIDC 2012a) which is significant for several reasons. First, the sea ice extent dropped below the 2007 low on August 26, approximately three weeks before the minimum sea ice extent is traditionally recorded in

September of each year. Second, the sea ice extent, for the first time since 1979, is below 4 million square kilometers, 18 percent below 2007 and 49 percent below the 1979 to 2000 average (NSIDC 2012b). Less sea ice covers the Arctic Ocean today than at any time in recent geologic history (Polyak et al. 2010).

Coastal communities located in western Alaska depend on Arctic sea ice to protect them from the storms that originate in the Bering and Chukchi Seas. These storms, though technically not hurricanes, can cause hurricane-strength damage on the coast due to wave action and storm surges (Shulski andWendler 2007). The seas are traditionally frozen from early November to mid-May. Nearshore pack ice creates a protective barrier to storm surges that cause flooding and erosion. The decreased Arctic sea ice extent coupled with warming temperatures has caused a delay in the freezing of the Bering and Chukchi Seas (Hufford and Partain 2005). Since the 1980s, the Arctic seas have remained ice-free approximately three weeks longer in the autumn (Hufford and Partain 2005). This delay in freezing of the Arctic seas prevents the nearshore pack ice from forming and exposes many coastal communities to the flooding and erosion caused by storms that originate in the Bering and Chukchi Seas and occur primarily between August and early December (Shulski andWendler 2007).

The land itself is also affected by temperature increases. Permanently frozen subsoil – permafrost – keeps the land intact and habitable along the northwestern Alaskan coast (GAO 2009, 7), but this frozen subsoil is melting (Serreze 2008). According to the 2007 IPCC report, the temperature of the top layer of permafrost has increased by up to three degrees Celsius since the 1980s (Lemke 2007). Melting permafrost causes infrastructure, including water and sewage systems, to sink into the earth and alters the structural integrity of these buildings.

Finally, climate change is also predicted to cause broad changes to wildlife abundance and distribution because of warming sea temperatures, changing vegetation patterns and ocean acidification (ACIA 2004; Markon 2012). Changing climatic conditions are expected to result in new vegetation patterns in Alaska causing the displacement of native species. Climate models predict that approximately 60 percent of the major plant and animal biomes in Alaska are expected to change (Murphy et al. 2010). Later freezing, earlier thawing and warming air and water temperatures may contribute to the appearance of new species and changes to the numbers and distribution of native species (NOAA 2010, Bhat et al. 2010). These changing vegetation patterns will impact the migration patterns of animal and bird life, which will affect the ability of the Alaska Native population to gather their traditional subsistence foods (Kofinas et al. 2010).

Changes in the ocean's circulation pattern, acidity level and temperature will affect marine life. Ocean acidification occurs as a result of increasing concentrations of carbon dioxide in the atmosphere, which the ocean absorbs. This acidification is expected to affect the ability of corals and mollusks to produce shells and skeletons (Adaptation Advisory Group 2010). Acidification may also affect the population of fish and marine mammals through a reduced availability of some of their food sources, such as krill, a crustacean, which is low on the food chain (Adaptation Advisory Group 2010; Schramm 2007).

Warming sea temperatures in the Bering Sea between 2000 and 2005 resulted in lower numbers of species that require sea ice (Overland et al. 2010). Plankton, a major source of productivity in

northern waters and a critical part of the food web, may be affected by earlier melting of sea ice. As the ice retreats, the timing and location of phytoplankton blooms may change (Simpkins 2010). Krill feed on these phytoplankton blooms. Changes in the timing of these blooms may affect the krill population.

A warming climate also affects marine mammals that are dependent on sea ice for their habitat and hunted by Alaska Native peoples, including bowhead whales, beluga whales, ringed seals, bearded seals, walrus, and polar bears (Simpkins 2010). Less arctic sea ice is projected to reduce marine mammal populations (Adaptation Advisory Group 2010). Warmer ocean and stream temperatures may also be a factor in recent declines of salmon stock (Farley et al. 2005, Mundy and Evenson 2011).

These changes to the hydrosphere, biosphere, cyrosphere and atmosphere are occurring faster than many of the climate models predicted and affect the totality of the environment where humans exist in Alaska. Due to the rapidity with which these changes are occurring, communities face an unprecedented challenge to adapt (Markon 2012).

Tetra Tech 2010: Climatic Regions of Alaska[1]

THE IMPACT OF CLIMATE CHANGE ON ALASKA NATIVE RURAL VILLAGES

Alaska has more than 33,000 miles of coastline, 10,000 named rivers, thousands of unnamed rivers, creeks and springs and 3 million lakes (Shulski and Wendler 2007, USACE 2009, 1-1). Approximately 200 indigenous communities live along these navigable waters in order to travel and have easy access to the coast, rivers and lakes to fish and hunt (GAO 2003, 7-8).

Historically, the ancestors of the current residents of Alaska Native communities migrated among several coastal and inland hunting and fishing camps in order to gather subsistence harvests. They moved seasonally to follow the wild game and fish on which they depended for their survival (ANTHC 2011; Berardi 1999; Schweitzer et al. 2005; USACE 2008b, Marino 2012). For example, the ancestors of the current residents of Kivalina migrated along the

[1] [1] Tetra Tech, *Imperiled Community Water Resources Analysis*, June 2010, available at: http://www.climatechange.alaska.gov/iaw.htm.

Kivalina and Wulik rivers between 20 winter settlements. During the summer, they moved between 14 coastal settlements (Gray 2010). In the interior, the Koyukon Athabascans traditionally had 12 summer fish camps located on the Yukon River (DCRA 2012).

This migratory lifestyle changed during the late nineteenth and early twentieth century. The Alaska Native population consolidated into permanent settlements primarily because of the requirement by the U.S. Department of the Interior's Bureau of Education that Alaska Native children attend school (Berardi 1999; Darnell 1979; USACE 2008b, Marino, 2012). Barge accessibility to transport construction materials determined the location of the schools (USACE 2008b). The building of schools and sewage, water, and electricity infrastructure led to a change from seasonal migration to the establishment of permanent communities at the school sites selected by the federal government, limiting communities' ability to move (USACE 2009). . The settlement of the Alaska Native population into permanent communities has affected their ability to adapt to their changing environment through traditional migration patterns.

This changing environment includes erosion, which is the principal cause for displacement of Alaska Native villages Erosion is a natural process, which becomes a problem when it damages or destroys something of intrinsic or quantifiable value. Historically, communities could move away from areas affected by erosion because they did not depend on built infrastructure. However, the construction of public facilities such as power plants, schools, health clinics, and airports tie communities to the land and limits their ability to move (USACE 2009). Decreased sea ice extent, along with thawing permafrost, accelerates erosion and critically affects the habitability of the environment where coastal communities are located (ASCG 2008, 24-28). Near shore pack ice no longer creates a barrier to storm surges, which exposes coastal villages to erosion and flooding (ASCG 2008, 27).

The phenomenon of erosion on Alaska Native communities is well-documented. Several communities, including those which are now most threatened by erosion, began documenting the impact of erosion on their community in the 1980s in order to develop a long-term strategy for protection in place (Cox 2007). In addition, during this same period of time, the State of Alaska documented the impact of erosion on communities throughout Alaska (ADOT& PF 1984). More recently, the US Army Corps of Engineers (USACE), the US Government Accountability Office (GAO) and the Alaska Sub-Cabinet on Climate Change Immediate Action Workgroup (IAWG) have each issued numerous reports that document the increasing severity of erosion on Alaska Native villages. These reports, examined below, have used diverse methodologies to assess and prioritize the harm to these communities in order to inspire immediate action. The reports have also evaluated the past efforts to protect communities in place and the cost of future protection for threatened communities, including the cost and viability of community relocation (GAO 2009, USACE 2009, IAWG 2009, IAWG 2008b, USACE 2006a, GAO 2003).

In 2003, the GAO issued the first federal government report to document the impact of flooding and erosion on Alaska Native communities. Former Alaska Senator Stevens, Chair of the Senate Appropriations Committee, requested that the GAO (1) determine flooding and erosion impacts on Alaska Native villages; (2) identify and assess federal and state government programs that assist communities with flooding and erosion; (3) evaluate the flood and erosion protection

efforts, including cost estimates, in seven named villages; and (4) identify alternative programs that could protect Alaska Native communities from flooding and erosion (GAO 2003).

The GAO concluded that 86 percent (184) of the 213 Alaska Native villages are affected to some extent by flooding and erosion. Four communities – Kivalina, Koyukuk, Newtok and Shishmaref – were planning to relocate due to these environmental threats (GAO 2003). The GAO found that "while the problems are long standing, various studies indicate that coastal villages are becoming more susceptible to flooding and erosion due in part to rising temperatures" (GAO 2003, 2-3). The GAO also concluded that the two federal government programs primarily responsible for erosion and flood protection, the US Army Corps of Engineers and the Natural Resources Conservation Service, were unable to adequately provide these services to Alaska Native communities due to the recurring nature of the threats and funding restrictions (GAO 2003, 2-3).These findings prompted former Senator Stevens to hold a Congressional hearing in 2004 focusing on erosion in Alaska Native communities (United States Senate, 2004), at which witnesses echoed the findings of the GAO.

While in 2005 Congress authorized the relocation of specific communities at full federal expense, the relocations did not occur. Instead, the U.S. Army Corps used these funds to conduct studies to determine the viability of relocation and to assess relocation sites, including two reports, in 2006 and 2009, which assessed the impact of erosion on the habitability of communities in Alaska.[2]

The 2006 report only examined the erosion of seven communities – Dillingham, Bethel, Kivalina, Kaktovik, Shishmaref, Newtok and Unalakleet – and responded to questions which were incorporated into the authorizing federal legislation. These questions were: what are the costs of ongoing erosion, what would it cost to relocate a community, and how much time do these communities have left before they are lost to erosion if erosion protection was not constructed (USACE 2006).

The cost analysis compared the cost between prospective erosion control and relocation for three of these communities, Kivalina, Newtok and Shishmaref. The Corps found that the prospective relocation costs for Kivalina and Shishmaref – estimated to be a minimum of $95 million – far exceeded the cost of erosion control, which was $15 million and $16 million respectively. For Newtok, the Corps found that the cost of erosion protection and relocation were almost equal.[3]

[2] In 2005, Congress enacted Section 117 of the Energy and Water Development Appropriations Act of 2005, which authorized the U.S. Army Corps of Engineers (USACE) to relocate specific communities at full federal expense (Energy and Water Development Appropriations Act of 2005, Pub. L. No. 108-447, § 117, 118 Stat. 2935, 2944–45 (2004). Despite this authority, no community was relocated between 2003 and 2009 when Section 117 authorized these actions. This legislation also appropriated specific funding for the erosion assessments..

[3] The Corps acknowledged in the report that the traditional cost/benefit analysis was not appropriate to determine whether relocation was cost effective in comparison to erosion protection. The Corps specifically found that the non-monetary costs, such as cultural cohesiveness, subsistence access and public health and safety issues, needed to be included in the analysis and had not been for the report. The Corps relocation cost estimates were also based on the federal government funding the entire relocation effort and did not consider the existing state funding traditionally available to communities to build and renovate community infrastructure, such as schools and health clinics.

The 2009 USACE evaluated the impact of erosion in 178 communities in Alaska, ranked the erosion condition and urgency of corrective action and prioritized twenty-six communities for immediate federal, state and local intervention. The Corps also listed the previous erosion control projects and their costs (USACE 2009). Although many of the communities reported flooding as the primary cause of erosion, the Corps did not assess flooding damage due to limitations in the Congressional authorizing language which focused exclusively on an erosion assessment (USACE 2009).

In 2007, the State of Alaska recognized the need to develop a statewide strategy to understand and respond to the impact of climate change. Former Alaska Governor Sarah Palin officially formed the Alaska Climate Change Sub-Cabinet (Palin 2007). The Sub-Cabinet was charged with "building the state's knowledge of the actual and foreseeable effects of climate warming in Alaska, developing appropriate measures and policies to prepare communities in Alaska for the anticipated impacts from climate change, and providing guidance regarding Alaska's participation in regional and national efforts addressing the causes and effects of climate change" (Palin 2007).

The Alaska Climate Change Sub-Cabinet established the Immediate Action Workgroup (IAWG), in 2007. The IAWG was a collaborative multidisciplinary and intergovernmental workgroup tasked with the responsibility of identifying the immediate needs of the communities imminently threatened by the effects of erosion, flooding, permafrost degradation, and other climate change-related impacts (IAWG 2008b).[4]

The IAWG used the criteria in the 2003 GAO report and the 2006 Corps report to identify the six communities – Kivalina, Newtok, Shishmaref, Unalakleet, Shaktoolik and Koyukuk – most imperiled by climate change and in need of immediate action (IAWG 2008). All are communities with a majority of Alaska Native residents. The IAWG facilitated numerous meetings with representatives of these communities to develop a strategy to respond to climate-related threats and was instrumental in advancing to the Alaska State Legislature funding recommendations for these communities so that they could receive the necessary financial resources to respond to the changing environment. The IAWG also issued two reports outlining several recommendations to respond to the needs of the imperiled communities located along Alaska's coast and rivers (IAWG 2008b, IAWG 2009).

Relying on the 2009 USACE report and the work of the IAWG, the GAO also issued a report in 2009. The GAO analyzed the impact of erosion and flooding on Alaska Native communities, as the USACE did not include flooding impacts in their erosion assessments and also analyzed the reasons for which none of the imperiled Alaskan villages had relocated. Evaluating the funding and governance mechanisms that could be used to facilitate community relocation, the GAO found that a lack of a federal lead relocation agency and relocation institutional framework inhibited community relocation efforts.

[4] Deputy Commissioner of the Alaska Department of Commerce, Community and Economic Development, Michael Black, and Patricia Opheen, Chief of the Engineering Division of the Alaska District of the US Army Corps of Engineers, were co-chairs of the Immediate Action Workgroup (IAWG 2008b)

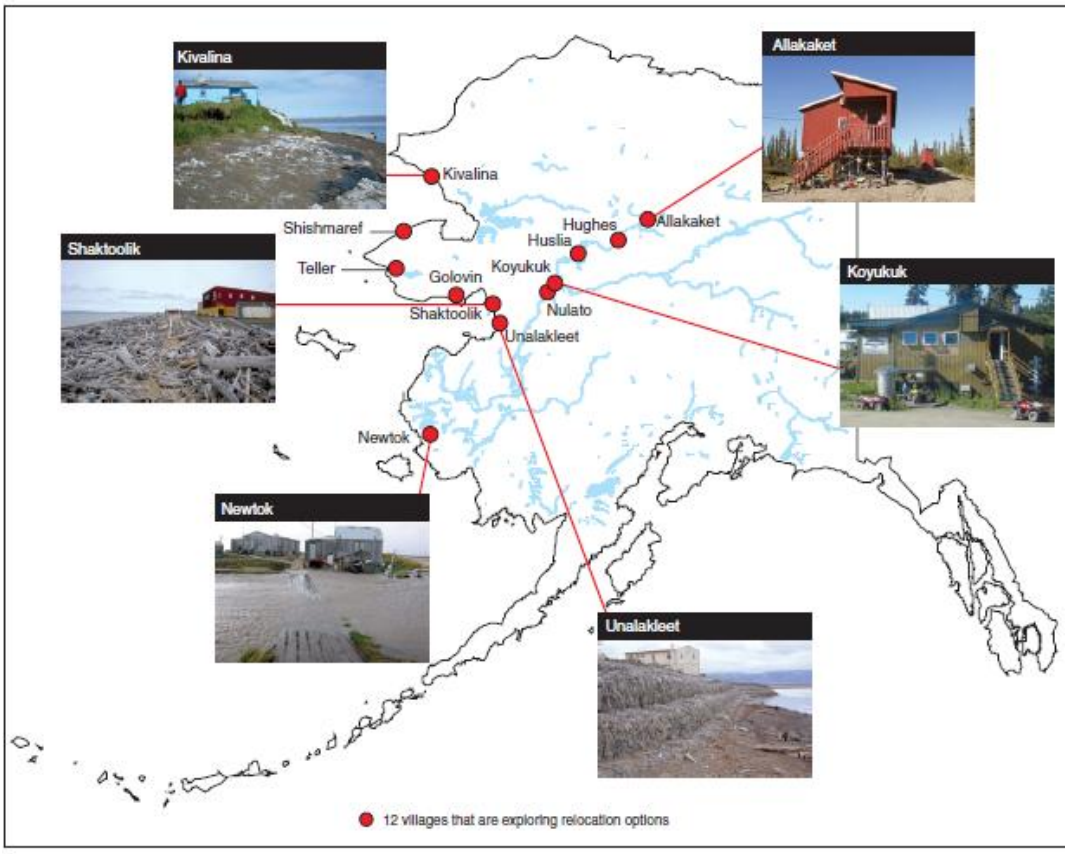
Based on the GAO (2009) assessment of flooding information and on the work of the Alaska Governor's Sub-Cabinet on Climate Change Immediate Action Workgroup, the GAO added five communities to the prioritization list created by the U.S. Army Corps of Engineers in 2009. For example, the 2003 GAO report identified the village of Koyukuk as a 'threatened' community and it was targeted for priority action by the Immediate Action Workgroup. However, the village was not included on the 2009 Corps' list of priority communities because it primarily suffers from repetitive flooding, rather than erosion.

The GAO found that erosion and flooding imminently threatened 31 Alaskan communities, and that the number of Alaskan villages seeking to relocate due to the immediate threat of climate-induced environmental change had tripled from their 2003 report to twelve (GAO 2009, 16). Standard, defensive adaptation strategies to protect coastal communities from erosion, such as rock walls and sandbags, have been largely unsuccessful (Adaptation Advisory Group 2010).

The GAO broke the twelve communities into two groups based on the type of forced displacement the community experienced, as further discussed below. Communities able to gradually migrate to higher ground located near the current village location comprised the first group. The second group of communities needs to relocate in their entirety because there is no higher ground close to the community and because all of the land on which the community is located is exposed to flooding and erosion

All twelve communities are geographically remote, with year-round access limited to small planes. Each village is a federally-recognized indigenous tribe.[5] Subsistence food gathering is central to their culture and survival (GAO 2009). Subsistence "links the harvester to heritage of countless generations of ancestors who harvested the same species, often in the same geographical location" (Gray 2010). Village life revolves around subsistence activities, with the resources obtained from the natural environment forming the basis for community cohesion, social identity, livelihoods and cultural events (ACIA 2004). Villages have small cash economies, with limited work opportunities. Store-bought food is expensive due to the high cost of transporting food to rural communities. Hence, subsistence harvests are critical to food security. Climate change will impact subsistence harvests by changing the distribution and abundance of wild foods (Adaptation Advisory Group 2010, Gray 2010). Extensive wildfires and altered snow conditions will also affect the capacity of local people to access these resources (Kofinas et al. 2010). A decrease in use of subsistence foods from climate change-related impacts could lead to health problems including an increase in hunger, malnutrition and disease (ANTHC 2011).

[5] Indian Entities Recognized and Eligible to Receive Services from the United States Bureau of Indian Affairs, 73 Fed. Reg. 18,553, 18,557 (Apr. 4, 2008).



Location of 12 Alaska Native Villages That Are Exploring Relocation Options[6]

GRADUAL FORCED DISPLACEMENT OF COMMUNITIES

Eight of the twelve communities identified by the GAO are located in diverse and geographically remote areas in Alaska. Three of these communities – Unalakleet, Golovin and Teller – are situated along the northwestern Alaskan coast. The remaining five communities – Allakaket, Hughes, Huslia, Nulato and Koyukuk – are located along Alaska's largest rivers, the Yukon and Koyukuk. Limited information exists regarding the extent of erosion and flooding impacting most of these communities. Of these eight communities, five – Allakaket, Hughes, Koyukuk, Teller and Nulato – were not identified as priority action communities by the US Army Corps of Engineers because flooding is the primary cause of displacement and the Corps only assessed erosion—not flooding—impacts on Alaska Native communities. Some of these communities have already begun to gradually move buildings to higher ground located close to the original village site. However, for several of these communities, there is limited comprehensive information about climate-related threats to community habitability and the options to prevent community displacement.

[6] GAO, *Alaskan Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion*, June 2009, http://www.gao.gov/new.items/d09551.pdf.

The following section provides a brief overview of the climate risks associated with these eight communities and, where possible, a summary of the protection measures that have been taken to mitigate or avoid the impacts of erosion and flooding.

Climate Risks in Eight Communities

Allakaket, with a population of 95, is located on the south bank of the Koyukuk River, southwest of its junction with the Alatna River, approximately 190 air miles northwest of Fairbanks. Several Native groups live in the area, including Koyukon Athabascans and Kobuk, Selawik, and Nunamiut Eskimos (DCRA 2012). Two major floods have inundated the village. The first occurred in 1964 when 85 percent of the community was inundated (DCRA 2012). Thirty years later in August 1994, Allakaket was declared a federal disaster area when Koyukuk River flooding damaged or destroyed nearly every home and public facility in the village. According to the GAO (2009), villagers believe that most of the community infrastructure, including many homes, is within the floodplain.

Golovin is a blended Yup'ik and Inupiat Eskimo village, with a population of 167, and located 70 miles east of Nome on a point of land between Golovin Bay and Golovnin Lagoon on the Seward Peninsula (URS 2008, GAO 2009). The Corps' 2009 erosion assessment identified Golovin as a priority action community. There were four large-scale erosion events between 1992 and 2005, with three occurring annually between 2003 and 2005 (URS 2008). In addition, Golovin was declared a state flood disaster area in 2004 and 2005 (GAO 2009). These extreme weather events exacerbated the rate of erosion (URS 2008). Infrastructure at risk of damage includes the fish processing plant, roads, village landfill, water storage tanks, boat launch and utility poles. Some protection measures have been implemented, but damage is expected within the next 10 years (URS 2008, USACE 2009, Tetra Tech 2010). The community has begun to move infrastructure, including water and sewage facilities, to higher ground located near the original village site.

Hughes, with a population of 76, is a Koyukon Athabascan village. Most of the community infrastructure lies within the flood plain of the Koyukuk River, about 210 air miles northwest of Fairbanks (Tetra Tech 2010). Hughes has a long history of flooding, including reported floods in 1937, 1938, 1963, 1964, 1965, 1966, 1968, 1972, 1989, 1994 and 2006 (GAO 2009, Tetra Tech 2010). Heavy rains in August 1994 caused the worst flood disaster, which destroyed and swept away nearly all of the community's buildings, including homes (GAO 2009, Tetra Tech 2010). Residents were evacuated by helicopter to Fairbanks (Tetra Tech 2010). This history of flooding caused the GAO to identify Hughes as a priority action community which would need to gradually move infrastructure to the bluff above the floodplain. Some infrastructure is being built on a 500 foot bluff above the floodplain, but this area has pockets of ice-rich permafrost, which creates a high likelihood of erosion (Tetra Tech 2010). Hence, extensive geotechnical studies need to be done before new construction is built, to ensure that the structural integrity of new buildings will remain intact in the event the permafrost thaws, causes erosion and leads the land to slump (Tetra Tech 2010).

Huslia is a Koyukon Athabascan village, with a population of 255, located on the Koyukuk Flats on the north bank of the Koyukuk River, about 290 air miles west of Fairbanks. The USACE

(2009) identified Huslia as a priority action community because of river erosion that threatens the community. By 2019, multiple structures including homes, water lines, fuel tanks and the sewage lagoon are expected to be affected. The community has already relocated several structures to higher ground located near the original village site (USACE 2009).

Koyukuk, with a population of 89, is located on the Yukon River near the mouth of the Koyukuk River, 290 air miles west of Fairbanks. Residents are primarily Koyukon Athabascans. Koyukuk was identified in the GAO December 2003 report as an imminently threatened village seeking to relocate. Koyukuk faces three types of serious environmental threats: erosion, flooding and fires (IAWG 2008). The entire village of Koyukuk lies within the floodplain of the Yukon River (GAO 2009). Floods are often severe, inundating a majority of the village. In 2006, Koyukuk was declared a state disaster area when more than half the residents were evacuated due to unexpected river flooding. (GAO 2009) Erosion occurs when the river is not frozen and specifically during high flow events on the Yukon River which occur throughout the year, during spring break up ice jam events and significant rainfall events. The community began planning to relocate to nearby land above the Yukon River floodplain (IAWG 2008), but is now reevaluating its decision to relocate.

Nulato, with a population of 274, is a predominantly Koyukon Athabascan village located on the west bank of the Yukon River, 310 air miles west of Fairbanks. The village of Nulato was declared a disaster area in 2006 because of flooding caused by the breakup of river ice (GAO 2009).

Teller is an Inupiat Eskimo community, with a population of 256, and is located on a spit of land between Port Clarence and Grantley Harbor, 72 miles northwest of Nome, on the Seward Peninsula (Tetra Tech 2010). In 2004, Teller was surrounded by water on three sides and was declared a state sea storm disaster area (GAO 2009). In 2005, a Sanitation Facilities Master Plan report found that the community was imminently threatened due to coastal erosion that could isolate the spit from the mainland (Tetra Tech 2010). Teller's only access to potable water is also threatened due to permafrost degradation (Tetra Tech 2010). In addition, the school's sewage lagoon is located in an area at risk of flooding and erosion (Tetra Tech 2010). Damage to the sewage lagoon could result in a lack of school wastewater treatment, which will create a public health risk (Tetra Tech 2010).

Unalakleet, with a population of 274 people, is located on a four mile long spit of land that lies between Norton Sound and the mouth of the Unalakleet River, some 150 miles southeast of Nome and nearly 400 miles northwest of Anchorage. The majority of community residents are Alaska Native Unaligmiut. Unalakleet experiences erosion on both the ocean side, Norton Sound, and from the Unalakleet River because of its location at the river's mouth. Erosion along the ocean side of the community is more severe because of storm activity, which washes away the beach. Unalakleet was declared a state flood disaster area in 2003 and 2005. The 2005 storm caused severe erosion to the protective seawall, flooding the village (GAO 2009).

According to the 2006 USACE report, some homes and community infrastructure, including the community's water supply line and the gravel airstrip, which provides the only year-round access to the community, could be lost by 2016 if erosion protection methods continue to fail (USACE

2006a). Multiple protection measures have been implemented. In 2000 the Natural Resource Conservation Service (NRCS) constructed erosion protection consisting of gabions, wire baskets filled with rock, at a cost of about $1.3 million. A late November storm in 2003 caused severe damage to the gabions, which were repaired in 2007 (USACE 2006a, USACE 2009). The Corps began construction of a 1,500-foot rock revetment over the existing NRCS gabion revetment in 2010 to protect the community from further damage (USACE 2007, USACE 2009). The cost of the Corps project is estimated at $28 million.

The climate impacts experienced by these eight communities demonstrate the need to create a standardized process to evaluate on-going environmental changes and assess the viability of using traditional erosion and flood control infrastructure to protect communities in their original location. Unalakleet's experience with the failure of recently constructed rock revetment is not unique. The communities of Kivalina and Shishmaref, described below, have had similar experiences. Without a standardized assessment tool, government agencies will continue to invest in short-term measures that may not be able to provide communities multi-decade protection. The experience of the four remaining imminently threatened communities, described below, that have already decided to relocate, demonstrates the problems that arise from the failure to continually assess the viability of technology to provide long-term protection.

Communities Requiring Relocation in Their Entirety

The second group of imminently threatened communities identified by the GAO 2009 report included the communities of Newtok, Shishmaref, Kivalina and Shaktoolik. The GAO determined that these four communities must relocate in their entirety to a new location instead of moving individual structures to higher ground. All of these communities are located along the northwestern Alaskan coast, and no roads lead to or from these communities.

In Kivalina, the State of Alaska declared a disaster emergency in August 2012 because of record rainfall, which raised the water level of the two rivers closest to the community and flooded the village landfill, spreading contaminated waste and infecting the village water supply (Parnell 2012a, Parnell 2012b).

Newtok is a Yup'ik Eskimo village located along the Ninglick River near the Bering Sea in western Alaska (Cox 2007). Approximately 400 people reside in the village which is surrounded by flat marsh lands. Wave action and thermal degradation of the permafrost-rich riverbank are causing accelerated rates of erosion (Cox 2007). Between 1954 and 2003, approximately three-quarters of a mile of tundra eroded in front of the village (Cox 2007). In 2003, the GAO identified Newtok as 'an imminently threatened village.' The State of Alaska spent about $1.5 million to control the erosion between 1983 and 1989 (USACE 2008b). Despite these efforts, even greater damage to the community is expected by 2016 (USACE 2006). Erosion of the Ninglick River is projected to reach the school, the largest structure in the community, by about 2017 (USACE 2008a).

Six extreme weather events between 1989 and 2006 exacerbated the rate of erosion. The U.S. Federal Emergency Management Agency (FEMA) declared a disaster in five of these events (ASCG 2008) of which three occurred between October 2004 and May 2006 (ASCG 2008). These three storms accelerated the erosion and repeatedly "flooded the village water supply,

caused raw sewage to be spread throughout the community, displaced residents from homes, destroyed subsistence food storage, and shut down essential utilities" (USACE 2008a). Floodwaters from the 2005 storm completely surrounded the village, turning it into an island for several days. The 2005 storm also destroyed the Ninglick River barge landing, making it difficult to deliver essential supplies such as fuel to the village, creating a fuel crisis. The only other way to receive these supplies is in small 10-passenger planes that are impractical as they are cost-prohibitive and cannot bring large quantities of supplies.

Public infrastructure that has been significantly damaged or destroyed due to the combination of extreme weather events and ongoing erosion include the village landfill, barge ramp, sewage treatment facility, and fuel storage facilities (USACE 2008b). A new dump site located across the Newtok River from the village, built as a short-term emergency response in 1996, is still in use in 2012 (ASCG 2008). Garbage gathers on the village side of the Newtok River and can only be transported by boat across the river at high tide (ASCG 2008). The lack of a sanitary village landfill and sewage treatment facility is creating a public health crisis for the community. Between 1994 and 2004, 29 percent of Newtok infants were hospitalized in Bethel, located approximately 50 air miles from Newtok, with lower respiratory tract infections because of high levels of community contamination and the lack of potable water for drinking and hygiene/sanitation practices (ASCG 2008). Salt water also affects the potable water (Cox 2007).

Newtok inhabitants have voted three times, most recently in August 2003, to relocate to Nelson Island, nine miles from Newtok (Cox 2007). Newtok obtained title to their preferred relocation site, which they named Mertarvik, through a land-exchange agreement negotiated with the U.S. Fish and Wildlife Service (Cox 2007). Mertarvik is located nine miles south of the current Newtok community location and across the Ninglick River. No infrastructure exists at the relocation site (Bronen 2011). In 2006, the Newtok Planning Group, an ad hoc intergovernmental and multidisciplinary working group dedicated to Newtok's relocation and lead by the Newtok Traditional Council, began a strategic relocation planning process. Through their efforts, pioneer infrastructure including a barge landing, six homes and the foundation for an emergency evacuation center have been built. However, no electricity or sewage and water system currently exists at the site. The president of the Newtok Traditional Council is currently the first and only person to live at the relocation site.

In November 2007, the first meeting of the Immediate Action Workgroup occurred in Fairbanks, Alaska (IAWG 2007). Residents of the three most climate-imperiled Alaska Native communities, Kivalina, Shishmaref and Newtok, gave presentations and described the climate change impacts which were threatening the lives of their community members (IAWG 2007).

Stanley Tom, tribal administrator for the Newtok Traditional Council, presented for Newtok, summing up the "challenges" Newtok faces: "No agency has authority to lead relocation efforts; No funding specifically for relocation; Patchwork funding from agencies and grants," and noted that "Getting funding takes time that we don't have. We can't keep up with the erosion" (IAWG 2007).

Newtok continues to be the only community that has identified a relocation site, accepted by state and federal government agencies and by using existing funding streams available to

communities, community infrastructure is being constructed at their relocation site. However, Newtok is plagued by a painfully slow relocation process with no clear timeline for when community members will be able to relocate. The Newtok Traditional Council is working with approximately 25 different federal and state government agencies to build the infrastructure at their relocation. With no funding specifically designated for relocation and no governance mandate to prioritize the construction of infrastructure at Newtok's relocation site, the Newtok Planning Group must navigate a maze of regulations in order to move forward with the Newtok relocation effort. Hence, due to enormous legislative and institutional barriers, the relocation is occurring very slowly (Bronen 2011).

Shishmaref, an Inupiat Eskimo village, is located on Sarichef Island, which is a barrier island (USACE 2006a). The island, which is approximately one-quarter mile wide and three miles long, is in the Chukchi Sea, north of the Bering Strait and 30 miles south of the Arctic Circle. Approximately 600 people reside in the village (USACE 2006a). The 2003 GAO report identified Shishmaref as an imminently-threatened village. Erosion and littoral drift are causing the island footprint to move. Erosion is undermining buildings and infrastructure, causing several structures to collapse and fall into the sea, and erosion protection measures have been unsuccessful except for short periods of time.

In October 1997, a severe storm eroded the north shore of the island which resulted in the need to relocate 14 homes and the National Guard Armory (BEESC 2010). Five additional homes were relocated in 2002 (BEESC 2010). Other storms have continued to erode the north shore at an average rate of three to five feet per year. According to the Department of Homeland Security, Shishmaref had 5 floods between 1988 and 2005 (USACE 2009). Three of these events occurred between 2001 and 2005. The State of Alaska declared a state flood disaster in 2001, 2004 and 2005 (USACE 2009).

In 2006, the Army Corps of Engineers determined that the majority of existing community residences and critical community infrastructure, such as the school, will be lost to erosion by 2021 (USACE 2006a). The report found that the airport, which provides the only year-round access of the community to the rest of the state, and the sewage lagoon had the greatest vulnerability (USACE 2006a).

Meanwhile, numerous erosion control and facility relocation projects have been designed and constructed in an attempt to protect the community in place and provide more time to relocate the community. Between 1973 and 2009, the state, federal, and tribal governments invested about $16 million in shoreline protection to address the accelerating rates of erosion (GAO 2009; SERC 2002). Three projects were completed between 1992 and 2002 to relocate community infrastructure (USACE 2009).

In 2009-2010, a rock-wall barrier was constructed for protection along significant portions of the coast fronting the community. However, approximately one-third of the community, including the airport, residential structures and community infrastructure, remain exposed. In 2009, the USACE report stated that severe damage is expected by 2019 (USACE 2009).

To respond to the ongoing threats to the community, the Native Village of Shishmaref created the Shishmaref Erosion and Relocation Coalition (SERC) in 2001 (GAO 2009). In 2002, the SERC developed a strategic relocation plan identifying the steps it needed to relocate the community and the governmental and non-governmental agencies that could provide technical assistance and relocation funding (SERC 2002). The SERC has worked with multiple federal agencies and their contractors to identify a new, safe, and culturally-appropriate community location.

In 2002, residents voted to relocate the community, but did not choose a relocation site (SERC 2002) and in 2004 SERC chose Tin Creek, located approximately 11.6 miles from the current community location, as Shishmaref's preferred relocation site. In 2007, the community again decided that Tin Creek was the preferred relocation site to affirm their relocation decision (BEESC 2010). As a result of this decision, the US Army Corps of Engineers (USACE), mandated to providing engineering services to reduce risks from disasters, and the U.S. Department of Agriculture Natural Resources Conservation Services, (NRCS) mandated to help people reduce soil erosion and damages caused by natural disasters, began to study Tin Creek as a relocation site (GAO 2009).

Between 2004 and 2008, NRCS, USACE and Alaska Department of Transportation (DOT) conducted approximately six separate studies to evaluate the suitability of the relocation site (BEESC 2010). DOT determined that the community's preferred site at Tin Creek was unsuitable due to the presence of ice-rich permafrost that could thaw due to climate warming and create future problems for community habitability (BEESC 2010). As a consequence, the most recent relocation site analysis, conducted in 2010, recommended that the community continue to search for a relocation site (BEESC 2010).

At the first meeting of the above-mentioned Immediate Action Workgroup occurred in Fairbanks, Alaska in November 2007, (IAWG 2007), Tony Weyiouanna, the representative from the Shishmaref Erosion and Relocation Coalition, ended his presentation by stating:

> [The] no action option for Shishmaref is the annihilation of our community…We are unique, and need to be valued as a national treasure by the people of the United States. We deserve the attention and help of the American people and the federal government. [...]
>
> [We request] [t]hat Shishmaref be used as a State/federal demonstration project with maximum flexibility to determine what changes need to be made to lower the cost and impact of relocation, identify a State or Federal champion to facilitate State and federal agency coordination for relocation of communities. [...] Shishmaref, we are worth saving (IAWG 2007).

Kivalina is an Inupiaq Eskimo federally-recognized indigenous tribe located on the tip of a thin, six-mile-long barrier reef island in the Chukchi Sea, 83 miles north of the Arctic Circle (USACE, 2006b). Kivalina is the only village in the Northwest Arctic Borough that hunts bowhead whales, and also is a member of the Alaska Eskimo Whaling Commission. The estimated population of 406 live in houses clustered around the southern end of the barrier island bordered on the west by

the Chukchi Sea and on the east by Kivalina Lagoon (DCRA 2012). The GAO December 2003 report identified Kivalina as an imminently-threatened village which needed to relocate.

According to the USACE (2006), the Kivalina spit has historically experienced cyclic erosion and accretion on the Chukchi Sea side (USACE 2006b). Erosion has accelerated because of stronger storms that now occur during the winter months when the Chukchi Sea is less likely to be frozen because of increased temperatures. Significant storms that occurred in 1970, 1976, and between 2004 and 2007 caused erosion and in some cases flooded part of the community. Erosion accelerated by winter storms occurred in October 2004 and November 2005 and threatened the school and the village fuel tank farm, essential for community electricity (USACE 2006b).

During the 2005 storm, Kivalina residents attempted to protect their community by constructing a beach wall out of all available material, including 55 gallon drums, scrap metal from fuel storage tanks, and the fuselage of an abandoned cargo plane (ANTHC 2011). Despite these efforts, erosion caused the loss of 70 feet of shoreline (ANTHC 2011).

Between 2002 and 2007, six extreme weather events accelerated the rate of erosion. The state and federal government issued three disaster declarations (Gray 2010). The most recent extreme event was a hurricane-strength storm, which occurred in November 2011 (Israel November 9, 2011).

The erosion impacts infrastructure that is essential for the viability of the community in its current location. These include the only means of access to the community, the summer barge landing and the community's airstrip, the community's sole water source, and the stability of the community's sewage containment area (ANTHC 2011; USACE 2006b). According to the USACE 2006 report, extreme damage to oceanfront properties is expected by 2016 and the rest of the village will be lost to erosion by 2026 without erosion protection (USACE 2006).

However, multiple protection measures have been implemented, but residential, commercial and community infrastructure remain exposed and at risk. Federal, state and local government agencies completed nine erosion control projects between 1992 and 2007, including the construction of an erosion control project on the ocean side of the community in 2006 (USACE 2007).

In September 2006, federal government leaders arrived in Kivalina to celebrate the finalization of the multi-million dollar seawall. But before the celebrations could begin, a storm damaged 160 feet of an 1800 foot seawall and caused the officials to cancel the celebration (deMarban 2006). One year later, in September 2007, a storm, with a forecasted twelve- to fourteen-foot surge for the ten-foot elevation village, threatened the community. Residents feared that the seawall would not protect them, and 250 Kivalina residents evacuated their community in search of safety (Bragg 2007a, Bragg 2007b). Village leaders told the GAO that the evacuation was so dangerous that they would never again attempt an evacuation (GAO 2009).

Due to ongoing concerns about erosion, government agencies spent $15.5 million between 2007 and 2009, on a rock revetment project to armor a portion of the ocean side of the community (Gray 2010).

The community has held five elections related to relocation. In 1998 and 2000, the community voted to relocate and chose a relocation site, which the USACE later determined was unsuitable because of thawing permafrost and threats of coastal erosion (USACE 2006a, Gray 2010). Disagreement among government agencies regarding the geophysical requirements for a relocation site has exacerbated an extremely slow relocation process. Kivalina continues to search for a relocation site that meets federal and state government approval.

Kivalina is currently working with the Alaska state government agency responsible for community planning needs in Alaska instead of the USACE because the state has received funding through the Alaska state legislature and the federal Coastal Impact Assistance Program to facilitate relocation planning with the community. In January 2012, Kivalina community residents voted to construct a new school seven miles from their current location. Funding for the new school is coming from a lawsuit settlement agreement involving funding inequities that harmed rural Alaskan schools (D'Oro December 31, 2011). If the Alaska Department of Transportation and Public Facilities (DOT) funds construction of a road between the current community location and the school site, the road would provide an evacuation route during an extreme weather event, and the school may serve as pioneer infrastructure for community relocation.

Although government agencies and Kivalina residents concur that relocation of the entire community is the only adaptation strategy to ensure the long-term resilience of the community, there is no clear road map for relocation.

Shaktoolik is a federally-recognized indigenous tribe, with a population of 231 people. The people of Shaktoolik are descended from the Unalit and Malemiut people (Gray 2010). The community is located on a sand spit between Norton Sound and the Tagoomenik River (Gray 2010). Shaktoolik experiences riverine and coastal erosion due to its location. All village structure is located in two rows on either side of a single street that extends through the village. Most of these buildings are located within the 100-year flood plain (USACE 2009a, State of Alaska 1980).

The beaches have historically been susceptible to damage and erosion from storm conditions, tidal surges, and from the sea ice conditions. The State of Alaska declared a state flood disaster area in 2004 and 2005 (GAO 2009).

The 2005 storm cut off the village evacuation route to the south, inundating the road with floodwater and turning the village into an island (GAO 2009). Storm surge has propelled large driftwood close to village buildings and the bulk fuel storage facilities, creating huge debris piles on the shoreline.

Natural protection has eroded considerably in recent years from storms, leaving the community vulnerable to further storm damage (IAWG 2008). Risk includes isolation of the community if a

narrow spit that connects Shaktoolik to the mainland becomes eroded, which also would cut the community off from its source of fresh water (USACE 2009). In addition, erosion of the sand spit near the drinking water source could result in saltwater intrusion to the water supply (Gray 2010). Logs that float down the Yukon River are also destructive during storms surges (IAWG 2008).

Erosion now approaches village infrastructure, including the fuel storage facility, the school's sewage system and the village airstrip (Gray 2010, GAO 2009). The community is currently engaged in a relocation planning process (Gray 2010). One relocation possibility is the construction of a 14.6 mile road across the river the new site, which would cost $33.4 million. The next step for the road project is to undertake a planning and design effort.

GOVERNMENT RESPONSE TO CLIMATE-THREATENED COMMUNITIES

The State of Alaska has implemented two programs to address the emergent needs of communities faced with displacement. Based on the recommendations of the IAWG, in 2008, the Alaska Legislature established the Alaska Climate Change Impact Mitigation Program (ACCIMP) (3 AAC 195.040). Funding from the ACCIMP is limited to two community categories. Non-competitive funding is allocated to six communities designated by name that are currently threatened by climate-induced ecological change. The remaining funds are administered through a competitive grant process to communities based on an evaluation of four factors: (1) risk to life or safety during storm or flood events; (2) loss of critical infrastructure; (3) threats to public health; and (4) loss of 10 percent or more of residential dwellings. Communities that receive this funding to complete hazard impact assessments will then be eligible for additional funding to support adaptation activities, including relocation planning.

Shishmaref, Kivalina and Shaktoolik are three of the six named communities in the regulation. Through the ACCIMP, each community will receive funding for relocation planning so that they can each identify a relocation site that federal, state, and village officials agree are safe, sustainable, and desirable for the subsistence lifestyle of the villagers.

The second program is funded through US Fish and Wildlife Coastal Impact Assistance Program. Using the collaborative model the Alaska Division of Community and Regional Affairs (DCRA) established for the Newtok Planning Group, funding will be used by DCRA project staff to organize inter-agency working groups, which include tribal, local, regional, state, and federal stakeholders for the three communities. These working groups will develop strategic plans that respond to current and future threats to the well-being of community residents and infrastructure endangered by erosion, flooding and storm surge.

Unfortunately, the last meeting of the Immediate Action Workgroup occurred in March 2011 because the Workgroup failed to receive authorization from Governor Parnell or the Subcabinet on Climate Change to continue its work (IAWG 2011a, IAWG 2011b). No explanation has been given to explain the failure to reauthorize the work of the IAWG. The dismantling of the Immediate Action Workgroup creates a tremendous gap for communities faced with climate-related threats.

CONCLUSION

Flooding and erosion threaten the habitability of a significant number of Alaska Native communities. Community relocation may be the only adaptation strategy that can protect community residents. The 2009 GAO report recognized that no government agency has the authority to relocate communities, no governmental organization exists that can address the strategic planning needs of relocation, and no funding is specifically designated for relocation (GAO 2009, 24-27). Even with their survival in imminent danger, none of the villages identified in the 2009 GAO report has yet been able to relocate, owing to governance issues that must first be overcome.

The issues Stanley Tom and Tony Weyiouanna and others identified during the November 2007 IAWG meeting persist; these communities continue to be imperiled. The relocation challenges faced by Kivalina, Shishmaref and Newtok exemplify the need to create a governance structure which can better respond to the needs of communities when their environment is no longer habitable because of climate change. The Alaska Climate Change Impact Mitigation Program (ACCIMP) and the Coastal Impact Assistance Program are critical first steps to address the needs of communities facing displacement because of climate change. However, as the Government Accounting Office (2009) noted, no similar initiative exists at the federal government level.

The inability of government agencies to change their approach from protection in place to relocation further imperils communities for two reasons. First, current federal disaster response legislation, the Stafford Act and its amendments, requires that funding be spent on repairing and rebuilding in the original location of the disaster (Bronen 2011). For communities that are no longer habitable in their current location or located entirely within floodplains, this means that they are unable to receive government funding to repair and rebuild damaged infrastructure due to state and federal government regulations which prevent government expenditures on infrastructure built within flood plans. As the 2009 USACE report stated, '[t]he most appropriate response is prevention. Communities and those assisting communities with construction should not build structures within the 50-year erosion hazard zone or 50-year flood hazard zone' (USACE 2009). As a consequence, communities such as Newtok are unable to receive funding to repair damaged and deteriorating sanitation and sewage systems that endanger the health of community residents.

Second, no comprehensive governance framework exists that can evaluate when communities and government agencies need to shift their work from protection in place to community relocation. No method exists to determine whether and when a community can no longer be protected in place with traditional flood control and erosion protection devices. This determination requires a sophisticated integrated social and environmental assessment in order to evaluate whether a community needs to relocate in its entirety to a new location, can gradually move some of the infrastructure and residents to a location close to the original community or can be protected in place. Government agencies are spending millions of dollars to construct erosion protection devices which have an anticipated lifespan of ten years (USACE 2007; Bragg 2007a; Bragg 2007b). In order to efficiently use resources and prevent humanitarian crises, social ecological indicators could guide communities and government agencies to transition from protection in place to community relocation.

Funding also continues to be a significant issue for communities that have decided that relocation is the only adaptation strategy that provides protection. The state and federal governments have various programs to fund erosion protection, hazard mitigation and disaster relief (USACE 2009, GAO 2009, Bronen 2011). Each of these programs has specific fund requirements and limitations. None of the programs funds relocation specifically (GAO 2009). In addition, there are numerous barriers to use funding to which communities are entitled, such as funding for school construction, for building infrastructure at the relocation site (Bronen 2011).

The creation of an adaptive governance framework, which can dynamically respond to the needs of communities as climate change impacts habitability and the safety of residents, is critical. Congress should amend disaster relief legislation so that communities are able to use existing funding mechanisms to construct infrastructure at relocation sites that are not within the disaster area. Congress should also enact legislation to provide a relocation governance framework so that communities have the ability to relocate when the traditional erosion and flood control devices can no longer protect residents in place. In this way, the United States can create a model adaptation strategy that facilitates an effective transition from protection in place to community relocation that can serve as a model for governments throughout the world.

REFERENCES:

ACIA, 2004. Arctic Climate Impact Assessment. Cambridge University Press, Cambridge.

Adaptation Advisory Group. 2010. Alaska's climate change strategy: Addressing impacts in Alaska. Final Report submitted by the Adaptation Advisory Group to the Alaska Climate Change Sub-Cabinet. Juneau.

ADOT&PF, 1984. Task Force on Erosion Control, State of Alaska, Final Report, Juneau.

ANTHC, 2011. Climate change in Kivalina, Alaska, Alaska Native Tribal Health Consortium Center for Climate and Health, Anchorage.

ASCG, 2008. Village Of Newtok, Local Hazards Mitigation Plan, ASCG Inc. of Alaska Bechtol Planning and Development, Newtok.

BEESC, 2010. Shishmaref relocation plan update draft--final Shishmaref, Alaska Shishmaref Erosion and Relocation Coalition and Kawerak Bristol Project #210029, Bristol Environmental & Engineering Services Corporation, Anchorage.

Berardi, G., 1999. Schools, settlement and sanitation in Alaska Native villages. Ethnohistory, 46(2): 329-359.

Bhatt, Uma S., Donals A. Walker, Martha K. Raynolds, Josefina C. Comiso, Howard E. Epster, Gensuo Jia, Rudiger Gens, Jorge E. Pinzon, Compton J. Tucker, Craig E. Tweedle and Patrick J. Webber, 2010. Circumpolar Arctic Tundra Vegetation Change Linked to Sea Ice Decline. American Meteorological Society Vol. 14: 1-20.

Bragg, B., September 14, 2007. Fierce fall storm pounds Kivalina after most villagers flee, Anchorage Daily News, Anchorage, pp. A1.

Bragg, B., September 15, 2007. As winds abate, residents return to Kivalina, Anchorage Daily News, Anchorage, pp. B1.

Bronen, R., 2011. Climate-induced community relocations: Creating an adaptive governance framework based in human rights doctrine. New York University Review of Law and Social Change, 35(2): 356-406.

Cox, S., 2007. An Overview of Erosion, Flooding, and Relocation Efforts in the Native Village of Newtok, Alaska Department of Commerce, Community and Economic Development, Anchorage.

D'Oro, R., December 31, 2011. Kivalina voters consider new school 7 miles away, Anchorage Daily News, Anchorage, pp. A1.

Darnell, F., 1979. Education among the native peoples of Alaska. Polar Record, 19(122): 431-446.

DCRA, 2012. Alaska Division of Community and Regional Affairs. Community Database Online: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.cfm.

deMarban, A., September 15, 2006. New wall takes sea's first test, Anchorage Daily News, Anchorage, pp. B1.

Farley, E. V., J. M. Murphy, B. W. Wing, J. H. Moss, and A. Middleton, 2005. Distribution, migration pathways, and size of western Alaska juvenile salmon along the eastern Bering Sea shelf. Alaska Fisheries Research Bulletin 11:15–26.

GAO, 2003. Alaska Native Villages: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance, Government Accountability Office, Washington.

GAO, 2009. Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion, Government Accountability Office, Washington.

Goldenberg, S., 2010. Scientists investigate massive walrus haul-out in Alaska. the guardian, September 3, 2010.

Gray, G., 2010. Final Situation Assessment: Kivalina Consensus-Building Project, Glenn Gray and Associates, Juneau, Alaska.

Hufford, G. & James Partain, 2005. Climate Change and Short-Term Forecasting for Alaskan Northern Coasts.

IAWG, 2007. Meeting Summary, Nov. 6, 2007, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Fairbanks, Alaska.

IAWG, 2008a. Meeting Summary, Jan. 18, 2008, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Juneau, Alaska.

IAWG, 2008b. Recommendations Report to the Governor's Subcabinet on Climate Change, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Juneau, Alaska.

IAWG, 2009. Recommendations Report to the Governor's Subcabinet on Climate Change, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Juneau, Alaska.

IAWG, 2011a. Meeting Summary, March 3, 2011, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Anchorage, Alaska.

IAWG, 2011b. Meeting Summary, February 17, 2011, Alaska SubCabinet on Climate Change, Immediate Action Workgroup, Anchorage, Alaska.

IPCC, 2007. Summary for Policymakers. In: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Editors), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp. 7-22.

Israel, B., November 9, 2011. Bering Sea Storm: Where did Alaska's 'epic' storm come from?, Christian Science Monitor, Boston.

Kofinas, G. P., F. S. Chapin, III, S. BurnSilver, J. I. Schmidt, N. L. Fresco, K. Kielland, S. Martin, A. Springsteen, and T. S. Rupp, 2010. Resilience of Athabascan subsistence systems to interior Alaska's changing climate. Canadian Journal of Forest Research 40:1347-1359.

Lemke, P., Jiawen Ren, Richard B. Alley, Ian Allison, Jorge Carrasco, Gregory Flato, Yoshiyuki Fujii, Georg Kaser, Philip Mote, Robert H. Thomas & Tingjun Zhang, 2007. Observations: Changes in Snow, Ice and Frozen Ground, in Climate Change 2007: The Physical Science Basis, Cambridge University Press, Cambridge.

Markon, C.J., Trainor, S.F., and Chapin, F.S. III, (Editors), 2012. The United States National Climate Assessment - Alaska Technical Report. US Geological Survey, Virginia.

Marino, E., 2012. The long history of environmental migration: Assessing vulnerability construction and obstacles to successful relocation in Shishmaref, Alaska. Global Environmental Change, 22(2): 374-381.

Mason, Owen, M.J. William, O.H. Pilkey, 1997. Living with the Coast of Alaska. Duke University Press, Durham, North Carolina

Mundy, P. R. and D. F. Evenson, 2011. Environmental controls of phenology of high-latitude Chinook salmon populations of the Yukon River, North America, with application to fishery management. ICES Journal of Marine Science 68:1155-1164.

Murphy, K, Huettmann, F., Fresco, N., and J. Morton, 2010. Connecting Alaska landscapes into the future: Results from an interagency climate modeling, land management and conservation project. University of Alaska and U.S. Fish and Wildlife Service.

Murphy, K. 2011. Thousands of walruses haul ashore in Arctic Alaska. Los Angeles Times, September 14, 2011.

NOAA, 2010. Adapting to climate change: A planning guide for state coastal managers. Office of Ocean and Coastal Resource Management, NOAA. Silver Spring, MD.

NSIDC, 2012a. Arctic sea ice extent settles at record seasonal minimum. Arctic Sea Ice News and Analysis, September 19, 2012. http://nsidc.org/arcticseaicenews/.

NSIDC, 2012b. Press Release: Arctic sea ice reaches lowest extent for the year and the satellite record. National Snow & Ice Data Center, September 19, 2012. http://nsidc.org/news/press/2012_seaiceminimum.html

Overland, J, Wang, M. and J. Walsh. 2010. Atmosphere. In Arctic Report Card October 2010, http://www.arctic.noaa.gov/reportcard. Richter-Menge, J., and J.E. Overland, Eds.

Palin, S. 2007. Governor's Administrative Order 238. State of Alaska. Office of the Governor. September 14, 2007.

Parnell, 2012a. State of Alaska Declaration of Disaster Emergency, Alaska. State of Alaska, Juneau.

Parnell, 2012b. Press Release, Gov. Parnell Declares Disaster for Kivalina. State of Alaska, Juneau. http://gov.alaska.gov/parnell/press-room/full-press-release.html?pr=6235

Parson, E., Carter, L., Anderson, P., Wang, B. and G. Weller, 2009. Potential consequences of climate variability and change for Alaska. In Global Climate Change Impacts in the United States. U.S Global Change Research Program.

Polyak, L., Richard B. Alley, John T. Andrews, Julie Brigham-Grette, Thomas M. Cronin, Dennis A. Darby, Arthur S. Dyke, Joan J. Fitzpatrick, Svend Funder, Marika Holland, Anne E. Jennings, Gifford H. Miller, Matt O'Regan, James Savelle, Mark Serreze, Kristen St. John, James W.C. White & Eric Wolff, 2010. History of Sea Ice in the Arctic, 29 Quaternary Sci. Revs. 1757, 1773.

Schramm, M.J., 2007. Tiny Krill: Giants in Marine Food Chain. NOAA National Marine Sanctuary Program. http://sanctuaries.noaa.gov/news/features/1007_krill.html.

Serreze, M., 2008. Arctic Climate Change: Where Reality Exceeds Expectations, Witness the Arctic, Winter 2008/2009, at 3–4, http://www.arcus.org/files/witness-the-arctic/2009/1/pdf/wta2008_v13i01.pdf.

SERC, 2002. Shishmaref Strategic Relocation Plan, Shishmaref Erosion and Relocation Coalition, Shishmaref.

Shulski Martha & Gerd Wendler, 2007. The Climate Of Alaska. University of Alaska Press, Fairbanks.

Simpkins, M. 2010. Marine mammals. In *Arctic Report Card October 2010*, http://www.arctic.noaa.gov/reportcard. Richter-Menge, J., and J.E. Overland, Eds.

Tetra Tech, 2010. Imperiled Community Water Resources Analysis.

United States Senate, 2004. Alaska Native Village Erosion. Hearings Before The Committee On Appropriations United States Senate One Hundred Eighth Congress Second Session Special Hearings, Anchorage, Alaska. U.S. Government Printing Office, Washinton DC.

URS, 2008. The City of Golovin Multi-Hazard Mitigation Plan.

USACE, 2006a. Alaska Village Erosion Technical Assistance Program: An examination of erosion issues in the communities of Bethel, Dillingham, Kaktovik, Kivalina, Newtok, Shishmaref, and Unalakleet, U.S. Army Corps of Engineers, Alaska, Anchorage.

USACE, 2006b. Kivalina relocation master plan, U.S. Army Corps of Engineers, Alaska, Anchorage.

USACE, 2007. Information Paper Subject: Status of Protection/Intervention Actions At High risk Communities. US Army Corps of Engineers Alaska District.

USACE, 2008a. Revised environmental assessment: Finding of no significant impact: Newtok Evacuation Center: Mertarvik, Nelson Island, Alaska, U.S. Army Corps of Engineers, Alaska, Anchorage.

USACE, 2008b. Section 117 Project fact sheet, U.S. Army Corps of Engineers, Alaska, Anchorage.

USACE, 2009. Study Findings and Technical Report. Alaska Baseline Erosion Assessment. US Army Corps of Engineers Alaska District.

USGCRP, 2009. Global Climate Change Impacts in the United States. U.S. Global Change Research Program, Washington DC.

USGCRP, 2010. Global Climate Change Impacts in the United States. United States Global Change Research Program, Washington DC.
http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewalaska.htm#Permafrost%20Thawing
%20and%20Sea%20Ice%20Melting.