Public Infrastructure Summary

Section 1 - Impacts and Vulnerabilities

Infrastructure is the platform upon which our society functions. Public Infrastructure are the essential facilities and utilities under public, cooperative or private ownership that deliver goods and services to communities.

Climate change in Alaska is creating the following potential impacts for public infrastructure (with significant regional variation):

- Increased flooding and erosion
- Decreased duration (cold season) and extent (warm season) of shore fast sea ice
- Increasing freeze/thaw cycles
- Changing wind and precipitation
- Increased storm frequencies and duration
- Warming and thawing permafrost
- Increased fire risk

The Vulnerability of and Risk to Public Infrastructure is Growing. Most of these impacts are not new to Alaska. What is new is the increased magnitude, rapid development and progression, and increasing geographic extent of these impacts and affected communities. In some locations entire Alaskan villages are at immediate risk. In other locations critical roads and public buildings are at risk. The immediacy and level of risk varies by region, and locally within regions, adding to the challenge.

Knowing that one picture is worth 1,000 words, current examples of these impacts today in Alaska (and one from east Russia, which is facing similar challenges) are presented now.

"Sink hole" on shoulder of Goldstream Road 5 mi N. of Fairbanks

Thermokarst depression on the edge of the Geophysical Institute UAF parking lot (Fairbanks, Alaska). Surface disturbance related to the parking lot construction triggered the permafrost degradation and ground ice melting. This created a subsurface void within the ground. The roof of this void collapsed when surface and ground waters saturated the soils during Spring and beginning of Summer. Photo by Prof. Vladimir Romanovsky, University of Alaska Fairbanks.

Failed Seawall, Shishmaref. Photo Credit: Brice Eningowuk

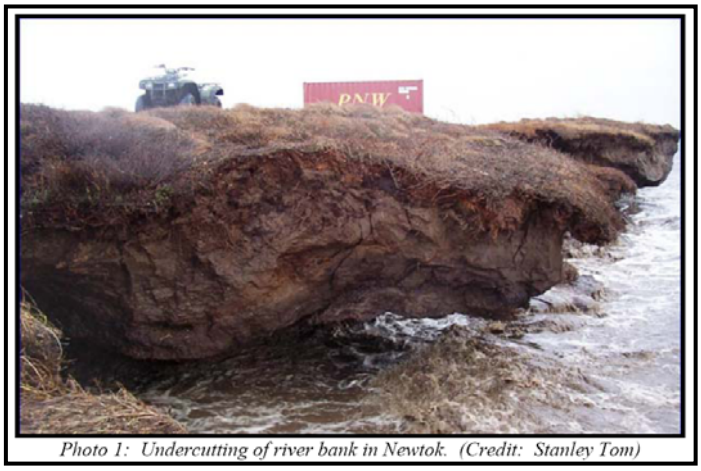


Photo 1: Undercutting of river bank in Newtok. (Credit: Stanley Tom)

Photo 5: Flooding during coastal storm in Newtok. (Credit: Stanley Tom)

Four-story apartment building in Cherski, North-East Yakutia (upper Kolyma River) was destroyed because of permafrost thawing and differential settlement in its foundation. It took only several days between the appearance of first cracks in the walls and the partial collapse of the building. Photo by Prof. Vladimir Romanovsky, University of Alaska Fairbanks.

Bluff erosion and permafrost melting in Shishmaref (c. 2002) Kawerak

Impacts from thawing permafrost on Alaska Highway north of Beaver Creek

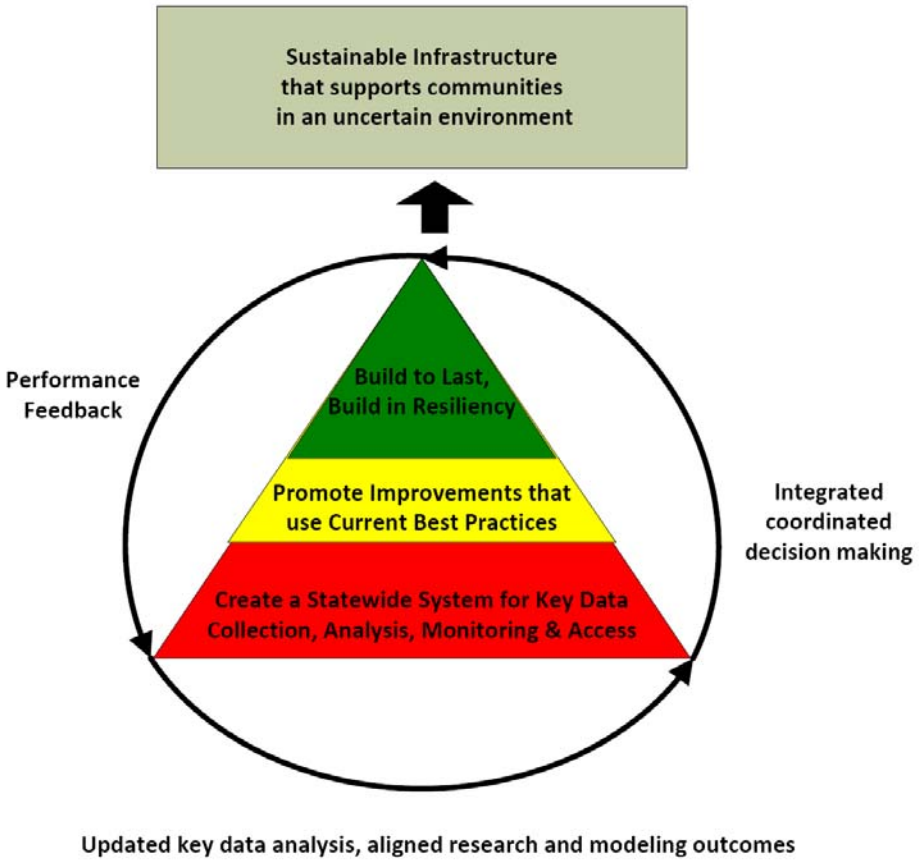
~~Infrastructure is the platform upon which our society functions.~~ Reliable and sustainable infrastructure is the foundation that the future of Alaska will be built upon. To ensure that Alaska is prepared to optimize investment opportunities and demonstrate that the return on investment for Alaska's current and future infrastructure provides good value for the state and the nation, an on-going, aligned statewide effort to monitor, analyze and proactively adapt to our changing environment is required.

Adaptive Capacity is Low. The adaptive capacity of public infrastructure is generally quite low. Most public infrastructure is hard and fixed (for example, roads, airport runways, bridges, buildings) and cannot easily alter its alignment, elevation, or structural foundation to accommodate coastal erosion or increased flood risk.

Increased Communication and Coordination is Critical. The challenge, and why an entity ~~to~~ that can increase communication and coordination is so strongly needed, is that impacted and potentially impacted communities, agency funders, and researchers often do not know about each other's planning efforts, infrastructure improvement projects, funding opportunities, or research, materials testing and demonstration project results. Information is not being shared with all who could benefit. The lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure. An entity is needed to facilitate communication both horizontally among partner agencies and vertically among the various layers of government and organizations.

Section 2 - Overview of Recommended Adaptation Options

The key design feature of the recommended adaptation options for public infrastructure is that it is an integrated system, as depicted below. The three policies (in the triangle) build upon and support one another. Continued, routine communication and feedback is essentially to adapt and refine actions taken over time.



Required Actions. The Public Infrastructure Technical Work Group (PI TWG) policy system to adapt Alaska's public infrastructure to a changing climate requires that four actions take place for both short and long term success.

1. **There must be across the board improvement in the coordination and accessibility of information.** This includes information on the condition of existing infrastructure and the environment where it is located; information on updated forecasts and trend analysis (such as rate of erosion, permafrost thaw, flooding); and ready access to community plans and infrastructure design.

2. **Collection, coordination and communication of pertinent information needs to start immediately. A program partner should be identified with the capability to organize and host an Information Center or Clearinghouse.** The Center would standardize, coordinate, and link data among the many differing sources to enable queries and integrated use. It would also track and index readily available and cost effective infrastructure development techniques that are working, that didn't work, materials development and testing results, developing designs, and contact information.

3. Impacted and potentially impacted communities, agency funders, and researchers frequently do not know about each other's planning efforts, infrastructure improvement projects, or funding opportunities. **Designate an entity (agency or agencies) to assume a coordinating role now.** A State of Alaska Executive Order is likely needed to establish this entity or structure. A senior-level executive should be manager. Implementation will be through existing agencies and authorities. An entity such as this will coordinate communication horizontally among partner agencies and vertically among levels of government and other stakeholders. It will streamline processes, eliminate duplicate efforts, and minimize unnecessary effort and transaction costs of developing and carrying out a statewide system.

4. Standing still while waiting for improved climate change data and forecasts is not an option, therefore **systematically use ~~best available technology~~current best practice when retrofitting existing and building new infrastructure.** Many of these improvements will be worth doing regardless of climate change effects.

The PI TWG 3-policy system to achieve sustainable infrastructure that supports communities in an uncertain environment is predicated upon these actions.

Section 3 - Option by Option Description

PI-1 Create a Statewide System for Key Data Collection, Analysis, Monitoring and Access.

The goal of Public Infrastructure Policy 1 (PI-1) is to establish a coordinated and integrated system to observe, collect, catalog, and disseminate data on the existing condition of public infrastructure and the environmental conditions where it is located. Use this information to prepare forecasts and trend analysis yielding up-to-date rates of erosion, permafrost thaw, flooding etcetera by region. Next, systematically assess the vulnerability of Alaska's public infrastructure in communities to establish the local level of risk. Share information in a useable format with communities to enhance understanding of climate change and the affect on the community, and to facilitate and coordinate project planning and development.

Four points to achieve:

A. Standardize information to be gathered. Establish a baseline and benchmarks so that data from differing sources can be compared and to enable analysis over time, regional geographic areas, and across agencies/parties. Set up system to consolidate and link data to enable queries and integrated use.

B. Gather data on condition of existing infrastructure. Organize data around designated climatic regions that are based on geopolitical boundaries. Gather data on ~~local~~ regional environmental conditions. Identify and fill data gaps over time. Use data to run predictive models to yield up-to-date erosion, flood, thaw (and other) rates and maps. Conduct systematic hazard analysis based on up-to-date regional climate data. Produce local vulnerability assessments to rank the risk level or vulnerability of existing infrastructure in communities. Determine status, capability and vulnerability of current infrastructure. Determine useful life of current infrastructure. Share in an actionable format to facilitate use of this data by local, tribal, state and federal users. Distribute results to: a) infrastructure designers, engineers and professional organizations, and b) municipal/tribal governments, state/federal agencies and NGOs.

C. Review agency infrastructure plans. Identify and resolve conflicts between agency plans. Determine future plan for use of current best practices~~best available technology~~ to repair, renovate, retrofit, replace or relocate.

D. Use a performance feedback loop to improve policy coordination, to update analyzes based on new information on weather, economic assumptions, or demographic changes, and to integrate results of research, foundation and material testing. Continually improve data alignment, scenarios, and assumptions for future infrastructure policies and plans.

These efforts are scalable. They can begin immediately and use existing resources and data. A starting place is to target a region or location known to be at high risk with vulnerable public infrastructure.

Enlarge and build the effort overtime.

A 'go to' Center or Agency or Clearinghouse is needed to standardize, coordinate, and link data among the many differing sources to enable queries and integrated use. The State of Alaska can play a coordinating role to bring state and federal agencies, university resources, professional organizations, local and tribal stakeholders and NGOs together. A coordinating agency must determine what technology is needed for systems to 'talk' to each other and what funding is needed to systematically identify, collect, analyze and disseminate data.

PI-2 Promote Improvements that use the Current Best Practices~~Best Available Technology~~.

The goal of Public Infrastructure Policy 2 (PI-2) is to use ~~best available technology~~ current best practices to make infrastructure improvements that are worth doing regardless of climate change's effects. This is both critical and practical because we can't stand still while we gather and analyze data and reduce the uncertainties associated with climate change. In the interim PI-2 focuses efforts on accomplishing actions that promote sustainability, reduce operating costs, and protect/extend the service life of existing infrastructure.

Examples include:

- Protecting key facilities from erosion/storm damage
- Installing energy conservation upgrades and using energy–efficient technologies
- Engaging in long term planning and preparedness

- Building local capacity for operating and maintenance

Implementation of PI-2 can begin immediately by:

1. Routinely gather and make available information on measures and practices that are, and are not, working to adapt infrastructure. A program partner should be identified with the capability to organize and host an Information Center or Clearinghouse for tracking sustainable and resilient best practices. This Center/Clearinghouse could index readily available and cost effective infrastructure development techniques that are working, that didn't work, materials development and testing results, developing designs, contact information, and more.

2. Integrate factors into agency infrastructure prioritization and funding formulas (for example Alaska DOT&PF STIP evaluation) to reward consideration of climate change and use of current best practices~~best available technology~~. Funding agencies could give higher scores to projects that:
   - Utilize proven infrastructure development techniques,
   - Integrate sustainability strategies, ~~or~~
   - ~~•~~ Include value engineering reviews to reduce operating costs~~.~~. ~~NEED BETTER SPECIFICS HERE~~
   - Have a completed project site vulnerability assessment for the proposed project linked to an existing overall community vulnerability assessment, or
   - Commit to proposed infrastructure performance reporting following project completion.

By systematically rewarding behaviors that promote the construction of more resilient and sustainable infrastructure, the State will be better prepared to meet the future.

PI-3 Build to Last; Build Resiliency into Alaska's Public infrastructure.

The goal of Public Infrastructure Policy 3 (PI-3) is to build to last by building resiliency into Alaska's public infrastructure. This can be done by:

1. Building in locations outside of hazard zones (that have been updated and defined using climate change modeling),

2. Building infrastructure to withstand the expected forces at the location over the life of the infrastructure, or

3. Designing and locating public infrastructure to meet acceptable risk limits.

To be successful we will need updated hazard zone locations, revised data on expected local forces and conditions for which infrastructure must be designed, research and testing of foundation designs and construction methods that can adapt to or withstand expected impacts, and modification of some engineering design standards, building codes, and operation and maintenance practices.

Three points to achieve are:

A. Meet or exceed infrastructure design life.

B. Optimize life cycle costs/asset management practices.

C. Create resilience to withstand expected weather events and a changing environment. Design infrastructure using the best science combined with appropriate building codes and engineering standards.

There are many ongoing applied research and technology projects looking to find ways to better predict climate conditions, more routinely locate infrastructure, and design infrastructure to better adapt to new conditions.

The challenge, and why an entity ~~to~~ that can increase communication and coordination is so strongly needed, is that impacted and potentially impacted parties do not routinely know about these and other efforts, nor are the results being routinely shared with all who could benefit. The lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure.

To be successful in implementing PI-3, PI-2 and PI-1, an entity (agency or agencies) must be designated and empowered to assume a coordinating role. A State of Alaska Executive Order is likely needed to establish this entity or structure. A senior-level executive should be manager. Implementation will be through existing agencies and authorities. An entity such as this will coordinate communication horizontally among partner agencies and vertically among levels of government and other stakeholders. It will streamline processes, eliminate duplicate efforts, and minimize unnecessary effort and transaction costs of developing and carrying out a statewide system.

Required Table

		Type of option										Timing of expected impacts			Components and timing of implementation			
		Coordination																
Option (number)	Short option name	State strategies and policies	State / federal program coordination	Community response and assistance	Data collection, management, monitoring	Access to data and "knowledge" sharing	Regulatory / programmatic change	Assessment, evaluation and planning	Capacity building , education, outreach	Capital improvements	Direct financial assistance or tax incentives	Impacts already observed	Impacts expected within a decade	Impacts expected over longer term	When implementation can or should begin? (# years)	Requires new institutions / government agency?	Requires new legislative authority	Limited lifetime or indefinitely lived?
PI-1	Data Collection, Analysis & Sharing	✓	✓		✓	✓	✓	✓	✓			PI already impacted; impacts will spread geographically over time			Now	New coordinating entity and new Clearinghouse needed		Permanent approach to business
PI-2	Current Best Practice~~Best Available Technology~~	✓	✓				✓		✓	✓					Now			
PI-3	Build to Last, Build in Resiliency	✓	✓				✓		✓	✓					~~now~~When updated data becomes widely available (2-3 yrs)			

Required Text Box Summaries

Mission Statement

Alaska has Sustainable Infrastructure that supports Communities in an Uncertain Environment.

Overview

This is a systems approach to reduce the impacts of climate change on Alaska's public infrastructure by accomplishing actions under three policies/programs:

PI-1 Create a Statewide System for Key Data Collection, Analysis, Monitoring and Access.
Baseline data on the condition of current infrastructure and local environmental conditions needs to be collected. We need to know where and what the problems are. We need to know what is working and what is not working. Based on the best science and collected empirical data we need to predict our future. The resulting information needs to be available to all interested parties.

PI-2 Promote Improvements that use the ~~Best Available Technology~~Current Best Practice.
Managing the risks and/or reducing the uncertainties associated with climate change will take time. Promoting sustainability, reducing operating costs, and protecting/extending the service life of existing infrastructure is always worthwhile. Simultaneous with PI-1, improvements to existing infrastructure that are worth doing regardless of climate change effects should be enacted.

PI-3 Build to Last; Build Resiliency into Alaska's Public infrastructure.
As PI-1 and PI-2 are enacted and we learn more as a result, new and upgraded infrastructure need to be planned, designed, and built to be resilient and sustainable in an uncertain environment. Systematic performance review and analysis feedback needs to be integrated into the public infrastructure funding, development, construction, and operations, so that planners and builders use "what works" and codes and standards are assessed and improved as needed to achieve the best results.

Evaluation Criteria

Early in the process the idea to develop a long list of each type of public infrastructure and the widely varying regional impacts that each might be subject to due to climate change was rejected. Instead, the group focused hierarchically on policies, programs and then specific actions or projects. To establish systematically retrofit and build new sustainable infrastructure in a changing and uncertain climate, discussion included: a) the sequence of policies and programs needed, b) the scalability of approaches - how to start immediately with current resources and enlarge and expand over time as resources and priorities allow, c) the benefits of approaches, and d) feasibility of implementation. No voting or balloting was used because the group's ideas were continually refined and combined to develop a focused approach with which all agreed.

Relevant Current Activities

There are many ongoing applied research and technology projects looking to find ways to better predict climate conditions, more routinely locate infrastructure, and design infrastructure to better adapt to new conditions. The challenge, and why an entity that can~~to~~ increase communication and coordination is so strongly needed, is that impacted and potentially impacted parties do not routinely know about these and other efforts, nor are the results being routinely shared with all who could benefit. The lack of routine coordination and information sharing raises costs, creates redundancies and adds inefficiencies to efforts to adapt Alaskan infrastructure.

Just a few relevant efforts are listed below.

1. SNAP-UAF hosts the Scenarios Network for Alaska planning (SNAP), a collaborative organization linking the University of Alaska, state, federal, and local agencies, and NGOs. The primary products of the network are (1) datasets and maps projecting future conditions for selected variables, and (2) rules and models that develop these projections, based on historical conditions and trends. Improvements to make the system and its results more user friendly are needed.

3. UAF Permafrost Research Project (partners: US Federal Highway Administration, Yukon Highways & Public Works, Alaska University Transportation Center, Transport Canada, Université Laval, Public Works and Government Services Canada) A 10-year project is testing 10 adaptive techniques including: Full ACE embankment, Full heat drain embankment, Covered ACE shoulder treatment, Uncovered ACE shoulder treatment, Heat drain should treatment, Longitudinal convection culverts, Heat drain shoulder treatment with insulation, Snow-free side slopes, Grass covered side slopes, and Light colored BST treatment.

4. Cold Climate Housing Research Center –Sustainable Northern Shelters Project was developed to address the needs of sustainable rural housing for northern climates.

5. ISER–UAA development of a preliminary and limited database of existing public infrastructure created to project the added cost (above normal wear and tear) from the effects of climate change on infrastructure at risk. See Larson, P.H., et al. ISER-UAA (2008) and Foster and Goldsmith (2008)

Research Needs