UA
Understanding Alaska

How Much Might Climate Change Add to Future Costs for Public Infrastructure?

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Scientists expect Alaska's climate to get warmer in the coming years—and the changing climate could make it roughly 10% to 20% more expensive to build and maintain public infrastructure in Alaska between now and 2030 and 10% more expensive between now and 2080.

These are the first estimates of how much climate change might add to future costs for public infrastructure in Alaska, and they are preliminary.

"Public infrastructure" means all the federal, state, and local infrastructure that keeps Alaska functioning: roads, bridges, airports, harbors, schools, military bases, post offices, fire stations, sanitation systems, the power grid, and more. Privately owned infrastructure will also be affected by climate change, but this analysis looks only at public infrastructure.

A warming climate will damage Alaska's infrastructure because it was designed for a cold climate. The damage will be concentrated in places where permafrost thaws, flooding increases, and coastal erosion gets worse. But the extra costs will likely diminish over time, as government agencies increasingly adapt infrastructure to changing conditions.

Keep in mind that we're ***not*** projecting how much Alaska's climate may change in the future. Scientists from around the world are doing that. We're estimating how much the future costs for public infrastructure in Alaska might increase, based on what scientists expect to happen.

The estimates are from a model we developed with UAA's School of Engineering and the University of Colorado at Boulder. They are in *net present value*, a method of estimating costs over long periods. (See note in Figure 1.)

• *Even without climate change, costs of maintaining and replacing public infrastructure in Alaska are considerable*—an estimated $32 billion between now and 2030 and $56 billion between now and 2080.

• *Damage from climate change could add $3.6 to $6.1 billion (10% to 20%) to future costs for public infrastructure from now to 2030* and $5.6 to $7.6 billion (10% to 12%) from now to 2080. These estimates take into account different possible levels of climate change and assume agencies adapt infrastructure to changing conditions.

• *Extra infrastructure costs from climate change in the next 25 years will mostly be for maintaining or replacing roads, runways, and water and sewer systems*. Those types of infrastructure are most vulnerable to thawing permafrost, flooding, and coastal erosion—and they're expensive to replace.

We're publishing these estimates, even though they're preliminary, because they show the magnitude of extra costs agencies could face and the potential value of efforts to mitigate climate change. We also hope they will stimulate more efforts to better understand and measure the problem.

We plan to improve both our modeling techniques and cost estimates in the future. To make those improvements, we need more information about existing infrastructure. We also need to refine our methods for estimating effects of climate change on building conditions and to learn more about techniques for adapting infrastructure. The climate projections we used are among the best available today—but as time goes on scientists will learn more about climate trends and will update their projections.

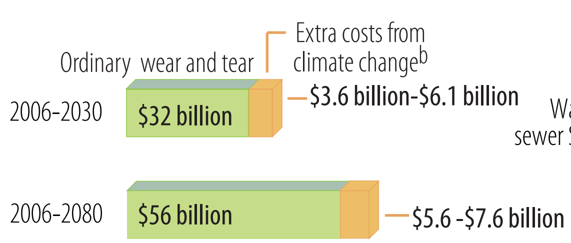
In the following pages we start by providing background about recent climate change in Alaska, using data from the Geophysical Institute at the University of Alaska Fairbanks. Next we discuss the climate projections that are the basis for our estimates, then describe the steps involved in creating our life-cycle model. Finally, we present our preliminary estimates of future infrastructure costs in more detail.

Figure 1. How Much Might Climate Change Add to Future Costs for Public Infrastructure in Alaska?

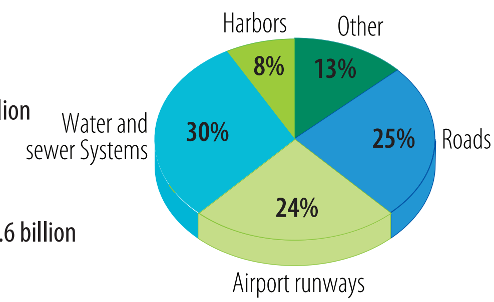
Examples of Public Infrastructure (Federal, State, and Local)

- Roads: 9,564 miles
- Airports: 253
- Bridges and harbors: 954
- Schools: 520
- Water and sewer systems: 366
- Railroad tracks: 819 miles
- Law enforcement, defense, emergency services, and health-care facilities: 841

Estimated Cost of Replacing Infrastructure as It Wears Out[a]



Likely Share of Extra Costs (By 2030)[c]



[a]These estimates are in *net present value*, which is a standard way of summarizing potential costs over long periods. Think of it as the amount that would need to be deposited in a bank today, earning interest, to cover all the costs for a project (or some other purpose) over a specified future period. [b]Depends on the level of climate warming and takes likely design adaptations into account. [c]Assumes moderate climate warming

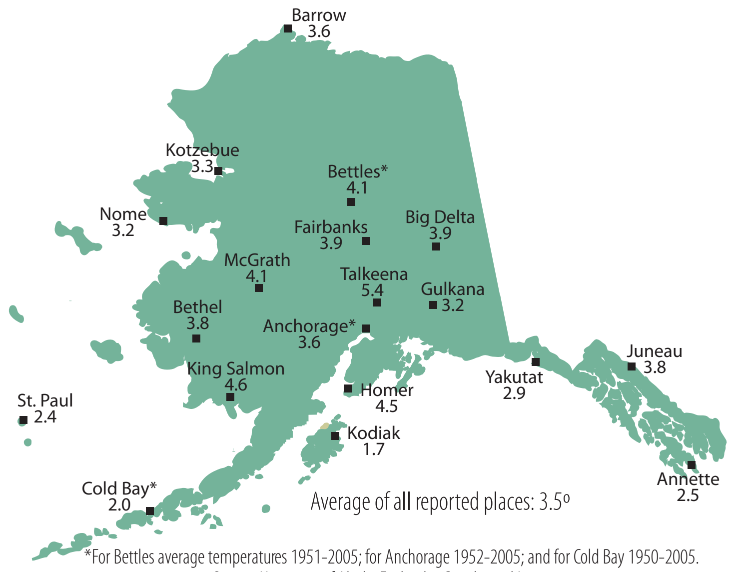
What is Happening?

Alaska's climate has gotten warmer in recent decades. Map 1 shows that average annual temperatures around Alaska increased from 2 degrees to 5 degrees Fahrenheit from 1949 to 2005. Climate models project that both temperature and precipitation will continue increasing in Alaska. The recent climate change was more pronounced in the Arctic than it was elsewhere—and scientists also expect future change to be more substantial in the Arctic.

The Intergovernmental Panel on Climate Change has concluded that people are responsible for much of the warming climate worldwide, by putting CO_2 and other greenhouse gases into the atmosphere. But natural climate variability and other factors also contribute. The findings aren't as definite at the scale of Alaska, but scientists believe much of the warming in the Arctic is probably also due to human activities, with natural variability playing a role.

Warmer temperatures will affect both natural and man-made systems in Alaska, with many economic and social consequences. One effect will be to increase building and maintenance costs for public infrastructure, although not all areas or all infrastructure will be equally affected.

Map 1. Increase in Average Annual Temperatures, Alaska Locations, 1949 - 2005, In Degrees Fahrenheit



*For Bettles average temperatures 1951-2005; for Anchorage 1952-2005; and for Cold Bay 1950-2005.
Source: University of Alaska Fairbanks, Geophysical Institute

About the ISER Model

With help from engineers at the University of Alaska and researchers at the University of Colorado, we created a model to begin assessing how much climate change could add to the future costs for Alaska's public infrastructure. We didn't attempt to estimate the economic value of mitigating greenhouse gases. We just looked at potential extra costs for infrastructure, given the projected changes in climate. Here are a few important points about our current model.

- The model deals with uncertainty about climate change by incorporating a range of climate projections. It also takes into account the natural variability in temperature and precipitation from year to year.
- The model uses thawing permafrost, increased flooding, and more coastal erosion to gauge damage to infrastructure.
- As a basis for estimating costs, the model uses the life span of infrastructure. We assume warming temperatures mean infrastructure has to be replaced more often. (It's also possible that the changing climate could actually increase the life of some structures, but we haven't so far identified any such exceptions.)
- These preliminary estimates are based on costs of replacing existing infrastructure as it wears out, in existing communities. So far we haven't estimated how the amount and location of public infrastructure might change in the future.
- The model assumes that costs of replacing any given type of infrastructure—say, schools—are the same statewide. We know that costs in remote areas are higher, but in our initial work we weren't able to account for such cost differences.
- Assumptions about future inflation and other factors, as well as characteristics of the model, are summarized in Table 4 on page 8.

Steps in Building the Model

Building the ISER model required several steps: (1) acquiring climate projections; (2) creating a database of public infrastructure throughout Alaska; and (3) estimating the replacement costs and life spans for existing infrastructure, with and without the effects of climate change.

Climate Projections: What's Expected?

To start our analysis, we needed to know what experts see for the future. In 2000, the Intergovernmental Panel on Climate Change (IPCC) issued a *Special Report on Emissions Scenarios*, which laid out a range of climate scenarios, each with specific assumptions about future levels of greenhouse gas emissions, population growth, and much more. One of those scenarios is known as the A1B scenario. That scenario is considered middle-of-the-road, and scientists from many countries use it when making climate projections.

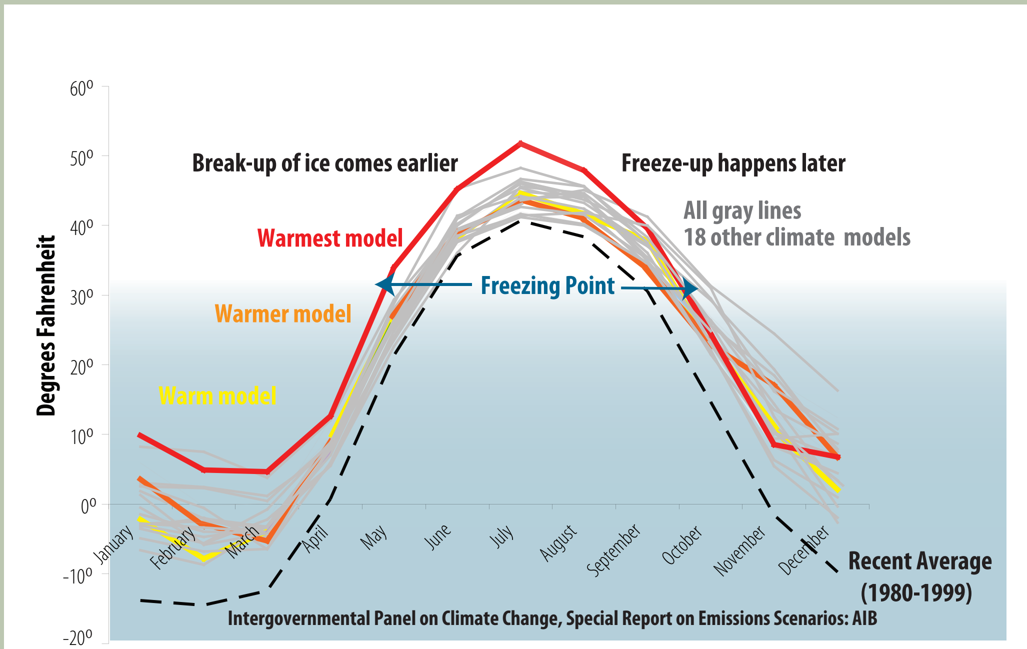
Joel Smith, one of the authors of a more recent IPCC report—the 2007 *Fourth Assessment Report*—asked the Institute for the Study of Society and the Environment at the National Center for Atmospheric Research to provide ISER with projections from 21 climate models based on the A1B scenario. He also recommended three of those projections for use in our analysis.

Figure 2 shows how the three climate projections we used—warm, warmer, and warmest—fit into the pattern of all 21 projections for Barrow in 2080. The warm model projection is from Australia, the warmer model projection is from the U.S. National Oceanic and Atmospheric Administration, and the warmest model projection is from Japan. (See back page for complete citations.) Notice that under any of the projections, temperatures around Barrow are expected to rise enough by 2080 that break-up of ice will come earlier and freeze-up later than today.

For this initial work, the National Center for Atmospheric Research provided us with projections for six representative locations around Alaska. (In later work, we plan to incorporate projections for more locations.) For areas where we didn't have projections, we estimated changes by interpolating from the known locations. Map 2 shows the locations of Alaska for which we had projections and compares projected temperatures with historical averages.

Precipitation is also expected to increase around the state, but not by as much as temperatures. Projected changes are small in the northern areas and larger in southeast Alaska, as Table 1 shows.

Figure 2. Climate Model Projections of Average Monthly Temperatures, Barrow, 2080



Map 2. Historical Average Annual Temperatures and Projected Temperatures in 2030 For Six Alaska Regions, From Selected Climate Models, In Degrees Fahrenheit

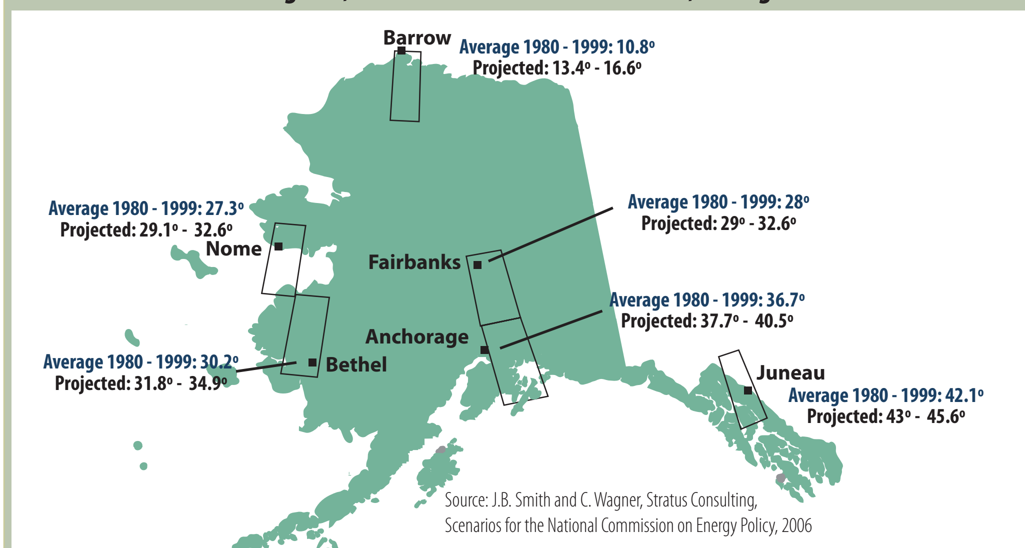


Table 1. Historical and Projected Annual Precipitation, Alaska Locations, From Selected Climate Models, In Inches

Alaska Location	Historical Precip. (1980-1999)	Warm Model Projection 2030	Warm Model Projection 2080	Warmer Model Projection 2030	Warmer Model Projection 2080	Warmest Model Projection 2030	Warmest Model Projection 2080
Anchorage	16.8	17.7	17.4	17.5	19.4	17.5	20.2
Barrow	4.2	4.3	4.7	4.4	4.8	4.5	5.6
Bethel	16.7	18.1	18.6	17.7	18.1	17.5	20.4
Fairbanks	10.7	11.3	11.2	11.3	12.5	11.1	13.4
Juneau	61.0	60.3	65.2	64.9	73.1	63.3	73.3
Nome	17.4	19.2	20.2	18.2	19.3	18.8	21.8

Sources: Lawrence Livermore National Lab (PCMDI Collection); NCAR/ISSE; ISER - UAA, 2006; UAF Geophysical Institute, 2006

Assembling a Database and Estimating Replacement Values

Our next step toward estimating future public infrastructure costs for Alaska was trying to find out what exists today. We hoped to find out how much infrastructure there is, how long the various types typically last, where it's all located, when it was built, and how much it would cost to replace it.

We collected all the publicly available data about infrastructure around the state. We relied on many sources, including the State Office of Risk Management; the Denali Commission; and the Alaska Departments of Natural Resources, Transportation and Public Facilities, and Education and Early Development.

The available information isn't complete, and in some cases may not be accurate. Getting accurate information about all the public infrastructure in Alaska is difficult, for several reasons—including Alaska's huge size, security concerns in the aftermath of 9/11, and the fact that public agencies didn't necessarily have reasons to collect and maintain that information in the past.

There are about 350 cities, towns, and villages spread across the state's 375 million acres. Some are on road systems or are regularly served by ferries or airlines. But many are far from regular transportation systems and are accessible by water only part of the year and by air taxis or charter airlines year-round, weather permitting. Different federal, state, and local agencies are responsible for the different types of infrastructure in all those diverse places.

Map 3 helps illustrate just how scattered public infrastructure is in Alaska. It shows the general distribution of transportation infrastructure around the state—major roads, bridges, airports, harbors, and the Alaska Railroad. Other kinds of infrastructure are distributed in similar patterns.

A lot of infrastructure is concentrated in the more heavily populated areas of southcentral Alaska, along the major road systems into the interior, and in southeast Alaska. But there is also infrastructure in hundreds of small, isolated communities along river systems in the interior and southwest Alaska, along the coasts, on the North Slope, on the Pribilofs and other islands in the Bering Sea, and along the Aleutian chain.

We weren't able to verify all the information for the hundreds of communities in our database. But we hope that when government agencies see the information we have so far, they will tell us what we're missing or what we have wrong. Table 2 shows information in the database right now.

- *Currently the database contains nearly 16,000 individual elements of public infrastructure in 19 categories.* We placed each item in a category, identified it by location, and assigned it a useful life and replacement value. We also assigned each a set of values associated with local permafrost conditions, susceptibility to flooding, and proximity to the coast.

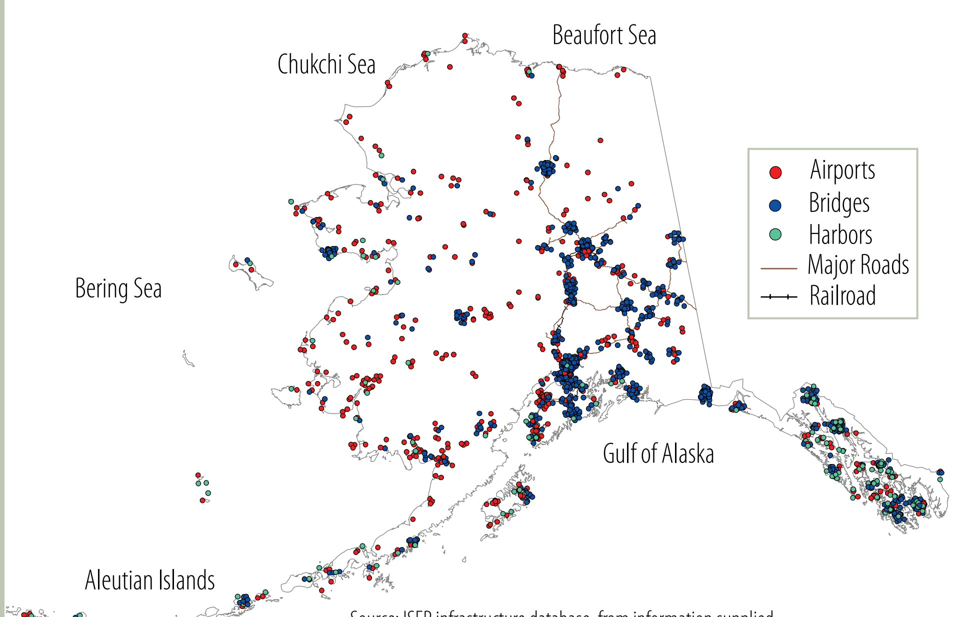
- *The infrastructure in our database has an estimated price tag of around $40 billion today*. Much of that is in various types of transportation infrastructure—especially roads—which are expensive to build and maintain in Alaska. Sanitation systems are also expensive to build and very difficult to maintain in remote northern, western, and interior places.

- *The database clearly undercounts and undervalues some types of infrastructure, especially defense facilities and power and telephone lines.* Information about the extent and value of defense facilities is often suppressed for reasons of national security. The database may also in some cases overcount infrastructure.

- *Agencies often don't report replacement costs for infrastructure*. Whenever possible, we got replacement costs from public agencies. But when no replacement cost was reported, we estimated, using average insured value or other available information.

- *Information on the expected useful life and the actual age of infrastructure in Alaska is also scarce*. For this initial work we made assumptions about the useful life of various types of infrastructure, based on information from the Alaska Division of Finance and personal communications with employees of government agencies and academic researchers. We also assumed, in the absence of specific information, that the various types of existing infrastructure are equally distributed along an age continuum, from new to near the end of useful life. The length of "useful life" varies among different types of infrastructure, as Table 2 shows.

Map 3. Transportation Infrastructure in Alaska, 2006



Source: ISER infrastructure database, from information supplied by Alaska Department of Transportation and Public Facilities

Table 2. Preliminary Public Infrastructure Database: Counts, Useful life, and Estimated Replacement Costs[a]					
Type of Infrastructure	**Count/Length**	**Useful Life (Years)**	**Replacement Cost per Unit (In $2006)**	**Units**	**Total Replacement Costs Today (In $2006)**
Airports	253	20	$20 million	Whole	$5.06 billion
Bridges	823 31.4 miles	40	$10,000	Per Foot	$1.7 billion
Court facilities	42	40	$16 million	Whole	$678 million
Defense facilities[b]	178	40	$305,000	Whole	$54 million
Emergency Services (Fire stations, other)	233	20	$467 ,000	Whole	$108 million
Energy (Fuel tanks, other structures off power grid)	234	30	$32 ,000	Whole	$7 million
Misc. government buildings	1,571	30	$1 million	Whole	$1.6 billion
Power grid (lines, transformers substations)[b]	68 768 miles of line	15	$100 ,000	Per Mile	$77 million
Misc. health buildings (clinics, other non-hospital facilities)	346	30	$1.6 million	Whole	$565 million
Harbors	131	30	$10 million	Whole	$1.3 billion
Public hospitals	18	40	$44.7 million	Whole	$806 million
Law enforcement facilities (police and trooper stations, prisons, other correctional)	66	30	$4 million	Whole	$259 million
Alaska Railroad	45 structures 819 miles track	30	$2.8 million	Per Mile	$2.3 billion
Roads	10,476 roads 4,564 miles paved 5,000 miles unpaved	20	$1 million (unpaved) $3 million (paved)	Per Mile	$18.7 billion
Schools	520	40	$2.5 million	Whole	$1.3 billion
Sewer systems	124	20	$30 million	Whole	$3.7 billion
Telecommunications (towers, satellites, other)	275	10	$300 ,000	Whole	$82 million
Telephone lines[b]	20 222 miles	15	$50 ,000	Per Mile	$11.1 million
Water systems	242	20	$5 million	Whole	$1.2 billion
Totals:	**15,665**				**$39.4 billion**

[a]Preliminary database, compiled from publicly available information in 2006.
[b]The counts and the replacement costs in these categories are obviously low, especially for defense facilities. In part for security reasons, little public information is available about the size and value of defense facilities.
Sources: Denali Commission; Alaska Departments of Transportation and Public Facilities, Administration (Risk Management), Commerce, Community and Economic Development, Natural Resources, Education and Early Development; ISER

Method of Estimating Additional Costs

The three climate projections and the infrastructure database gave us the foundation for building our life-cycle cost estimation model, to assess the effects of climate change on future infrastructure costs. We made estimates for the years 2030 and 2080, the years for which we acquired climate projections. (Those projection years are in fact averages for 20-year spans—2020-2039 for 2030 and 2070-2089 for 2080.)

• *Our model assumes that existing infrastructure is replaced as it wears out,* that it is replaced in the same community, and that no new infrastructure is added.

• *Our model assumes that climate change will damage infrastructure by thawing permafrost, increasing flooding, and creating more coastal erosion.* These effects will occur not only because of increasing temperatures and precipitation but also because the lack of shore-fast ice will make coastal places more vulnerable to erosion caused by storms.

• *Thawing permafrost and other changes can add to the costs of maintaining and replacing infrastructure in various ways*. But in this initial work we used a reduction in the useful life of infrastructure—meaning that it wears out faster and has to be replaced sooner—as a proxy for different ways the costs of infrastructure might increase.

• *We first estimated infrastructure replacement costs in the coming years, assuming no climate change*. That estimate served as the basis for assessing additional costs that could result from climate change. Infrastructure in Alaska is expensive to build and maintain, even without taking climate change into account.

• *We then estimated a range of additional building and maintenance costs resulting from climate change.* Most scientists believe Alaska's climate will continue to get warmer, but it's impossible to perfectly predict how much and how fast the climate will change over the next several decades. We took that uncertainty into account by (1) using three different climate projections and (2) applying the historical natural variability in annual temperatures and precipitation to each of the three projections, to assess the range of possible conditions—and therefore the range of possible additional costs. For each of the three climate projections, we did repeated model runs to assess the potential range of costs.

• *We first estimated additional costs assuming that agencies simply react as conditions change—the no-adaptation case*. They continue to design and construct infrastructure, taking local conditions into account, and finding new methods for dealing with problems as they develop. But in this case, we assume they don't act strategically—that is, they don't anticipate and plan for continuing trends in climate change and future vulnerabilities of infrastructure. We don't believe that in fact agencies would react so passively. Still, this no-adaptation case offers a useful starting point for further analysis. It provides a benchmark for measuring the efficacy of adaptation measures. It also gives agencies an idea of how big a problem they could face, in an environment of continuing change.

• *We next estimated costs assuming that agencies act strategically to minimize the ongoing effects of climate change on infrastructure—the adaptation case*. For example, they would try to design bridges to take into account projected climate change throughout the life of the bridge. We believe this adaptation case better reflect what agencies will actually do.

How Much Might Climate Change Add to Costs?

Our estimates of additional infrastructure costs are in *net present value*, which is a standard way of summarizing potential costs over long periods. Think of it as an amount that would need to be deposited in a bank today, earning interest, to cover all the future costs for something—in this case, the estimated additional costs for replacing public infrastructure through 2030 and through 2080.

Figure 1 on the front page summarizes our estimates of additional costs resulting from climate change, taking likely design adaptations into account. Those are the averages under each of the three climate projections, and it's most probable that costs would be close to those averages.

But there is some chance that the additional costs could be much higher or much lower than the averages. That's because in reality temperatures and precipitation in any given year vary from the averages. The three climate projections we used project trends in temperature and precipitation—but there will inevitably be years when either temperature or precipitation, or both, will be higher or lower than the trend projection.

Our model uses historical observations to project how additional infrastructure costs might vary, when temperature and precipitation differ from the projected average. We did repeated model runs—up to 100 for each climate projection—to estimate the range of possible costs.

Figures 3 and 4 show our preliminary estimates of the range of possible additional costs from climate change, taking likely adaptations into account, under each climate projection. Table 3 shows estimates of additional costs both with and without strategic adaptations to climate change. What do the figures and the table show?

• *Even without climate change, maintaining and replacing infrastructure in Alaska is an expensive proposition*—costing an estimated $32 billion between now and 2030 and $56 billion by 2080.

• *Climate change could add 10% to 20% to infrastructure costs by 2030 and 10% to 12% by 2080*, under different climate projections and taking design adaptations into account. The additional costs are relatively higher in the short run, because agencies haven't had as much time to adapt infrastructure to changing conditions.

• *Strategic design adaptations have much more potential to reduce extra costs in the long run.* Between now and 2030, adaptations might reduce costs related to climate change by anywhere from zero to as much as 13%, depending on the extent of climate warming. But between now and 2080, adaptations could save anywhere from 10% to 45% of costs resulting from climate change.

• *Transportation infrastructure—especially roads and airport runways—will account for most of the additional costs between now and 2030*. That's because transportation infrastructure is expensive to build and maintain in Alaska under any circumstances, and many airports and some roads are in areas that will be most affected by a warming climate. But water and sewer systems—which are very expensive to build and difficult to maintain in areas with a lot of permafrost—will also account for nearly a third of the costs resulting from climate change by 2030.

Figure 3. Range of Additional Public Infrastructure Costs, 2006-2030, Adaptation Case
(In Billions of Dollars, Net Present Value)

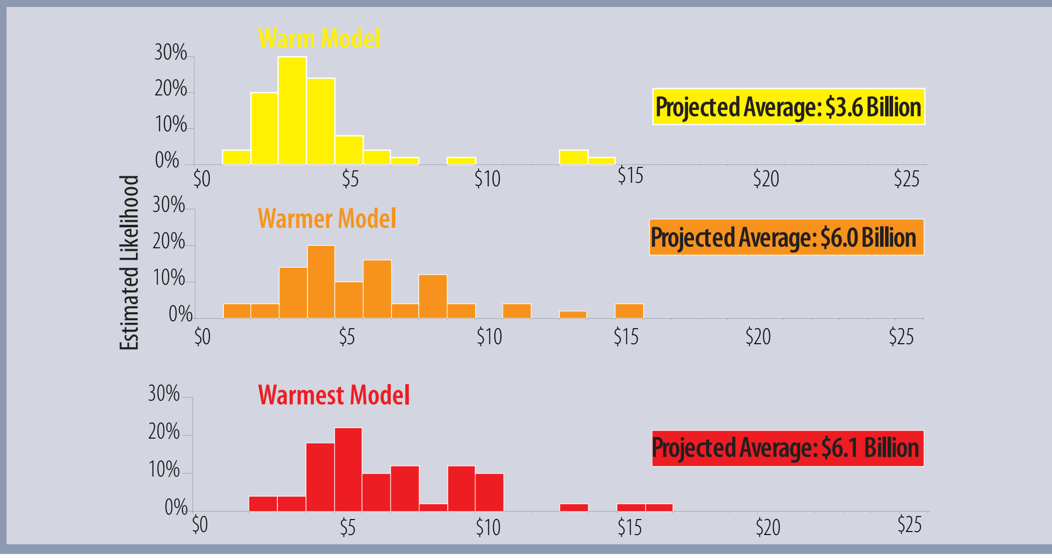


Figure 4. Range of Additional Public Infrastructure Costs, 2006-2080, Adaptation Case
(In Billions of Dollars, Net Present Value)

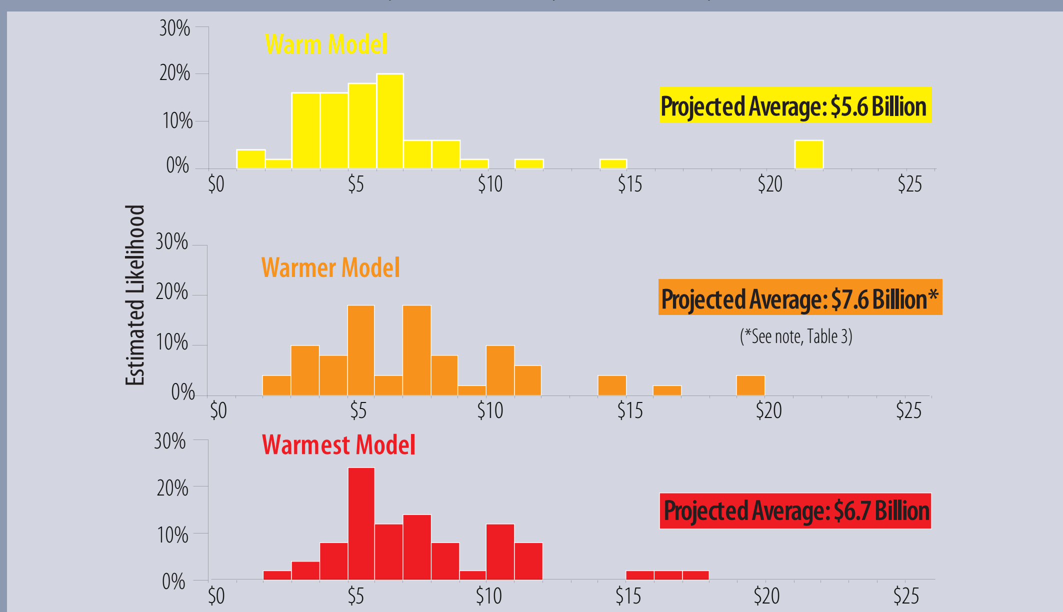


Table 3. Estimating Additional Infrastructure Costs From Climate Change
(In Billions of Dollars, Net Present Value)

	Ordinary wear and tear (No climate change)	Extra Costs from Climate Change						Potential Savings from Strategic Adaptations
		Warm Model		Warmer Model		Warmest Model		
		No Adaptations	With Adaptations	No Adaptations	With Adaptations	No Adaptations	With Adaptations	
2006-2030	$32	$3.6	$3.6	$6.1	$6.0	$7.0	$6.1	0%-13%
2006-2080	$56	$6.2	$5.6	$10.6	$7.6*	$12.3	$6.7	10%-45%

Warm model is CSIRO-Mk3.0, Australia; warmer model is GFDL-CM2.0, U.S. NOAA; warmest model is MIROC3.2.(hires), Japan.
*Although it seems counter-intuitive, additional costs are estimated to be higher under the warmer model than under the warmest model by 2080. That's largely because the ISER model projects that in the long run both the incentives for and the savings from adaptations would be greater under more rapid climate change than under more moderate change.

Table 4. Characteristics of ISER Life-Cycle Model	
Functional Form	Probabilistic life-cycle analysis
Discount Rate	2.85%/year (real)
Base Year	2006
Projected Years	2030, 2080
Depreciation Matrix Version	January 31, 2007
Climate Model Base Years	1980-1999
Observed Climate Variability Data Source	University of Alaska Fairbanks, Geophysical Institute
Distribution Shape for Observed Regional Climate	Gaussian
Extreme Climate Events Probability	Less than 1st percentile, greater than 99th percentile (for observed range of climate)
Extreme Climate Events Scalar	+10% increase in effects on useful life
Natural Variability Forward in Time	Static at observed regional annual variances
Infrastructure Growth Forward in Time	Static at 2006 count
Permafrost State Forward in Time	Static at 1965 location (USGS)
Software System	SAS 9.1 TS Level 1M3, XP PRO Platform
Hardware System	Dell Dimension 8300 (Intel Pentium 3.06 GHz; 500 GB Hard Drive)

Climate Models Used in Analysis

Warm Model

Modeling Group: CSIRO Atmospheric Research, Australia

Model Identification: CSIRO-Mk3.0

Warmer Model

Modeling Group: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory

Model Identification: GFDL-CM2.0

Warmest Model

Modeling Group: Center for Climate System Research (University of Tokyo); National Institute for Environmental Studies; and Frontier Research Center for Global Change (JAMSTEC), Japan

Model Identification: MIROC3.2(hires)

Directions for Future Research

We anticipate that continuing research in a number of areas will allow us to refine our model and the cost estimates, both for the state as a whole and for regions and particular types of infrastructure.

- *Climate projections*: Our technical advisors tell us that the climate projections we used in our analysis have a useful life of about two to five years. As time passes, we will need to get new projections. We hope the new generation of climate projections will be available for smaller geographic areas.
- *Infrastructure database*: We need more complete information about the count, the useful life, the age, and the replacement costs of public infrastructure in Alaska. What we have currently is a good start toward creating the first comprehensive database of federal, state, and local infrastructure in the state. Also, as time goes on and more public infrastructure is built, we need to work with public agencies to make sure new infrastructure is added to our database.
- *Changes in building conditions*: We need to learn more about how changes in temperature, storm severity, and other anticipated climate changes affect building conditions, including the stability of soils, erosion, and other factors.
- *Effects of building conditions on life-cycle costs of infrastructure*: We need to learn more about how changing building conditions resulting from climate change affect the life-cycle costs for infrastructure. Also, we need better information about how building on permafrost affects soil temperatures, regardless of climate change.
- *Maintenance costs:* We need to learn more about how changing building conditions resulting from climate change affect costs of maintaining infrastructure.
- *Adaptation techniques*: We need more information about the array of techniques that could be used to adapt infrastructure to changing climate conditions. What would specific adaptations cost? And which would not only ameliorate the effects of climate change on infrastructure but also be cost-effective?

About Shishmaref, Kivalina, and Newtok

The U.S. Army Corps of Engineers reports that increasing erosion along the Bering Sea coast means the villages of Shishmaref, Kivalina, and Newtok in western Alaska will need to be moved in the next 10 to 15 years, at an estimated cost of up to $455 million. We have not included that estimate in our cost projections, because it includes a very wide range of costs associated with relocating entire communities. The corps did not report what share is specifically for public infrastructure.

Acknowledgments

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This summary is based on *Estimating Future Costs for Alaska Public Infrastructure at Risk from Climate Change*, by Peter Larsen, Scott Goldsmith, Ben Saylor, and Meghan Wilson of ISER; Orson Smith of UAA's Civil Engineering Department; and Ken Strzepek and Paul Chinowsky of the University of Colorado at Boulder. It is available online at www.iser.uaa.alaska.edu, or from ISER's offices in Anchorage (907-786-7710).

The authors ask that any one with better information about public infrastructure in Alaska, or comments about our research methods, please call or send an e-mail message to Peter Larsen at 907-786-5449 or ANPHL@uaa.alaska.edu.

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