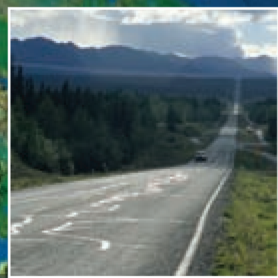
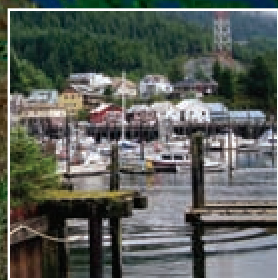
Costs of Global Warming for Alaska's Public Infrastructure





ISER

UAA

Colorado
University of Colorado at Boulder

CONTEXT

A warming climate results in:

Thawing ground

- *Undermining foundations of buildings, roads and runways*

Retreating sea ice

- *Increasing coastal erosion due to storms and wave action*
- *Coasts once protected by ice become increasingly vulnerable*

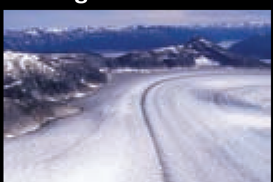
Increasing precipitation

- *With more rain coming in heavy downpours*
- *Coastal and riverside locations most vulnerable to flooding and erosion*

No place on Earth is warming faster than Alaska. Temperatures in the state have risen by several times the global average over the past 50 years. Warming is already having significant impacts throughout Alaska and is expected to cause more extensive damage in the future. Among the observed changes resulting from this warming are melting glaciers, rising sea levels, retreating sea ice, declining snow cover and lake ice, thawing permafrost, increasing rain in autumn and winter, and increasing insect infestations and wildfires.

These changes are already affecting people in Alaska. Subsistence hunters are having increased difficulty acquiring food and maintaining their way of life. Marine fisheries and migratory patterns of wildlife are shifting. Freshwater fish such as arctic char and salmon are decreasing. Transportation routes are being disrupted as permafrost thaws and ice roads melt. Coastal towns are facing relocation at enormous expense. Insects are thriving in the warmer conditions, destroying entire forests. The impacts of warming are expected to worsen, with higher levels of warming causing more destructive impacts. The total costs of these impacts have never been estimated.

Melting Glaciers



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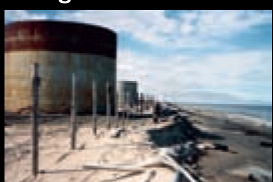
Rising Sea-level



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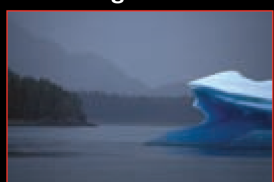
Retreating Sea Ice



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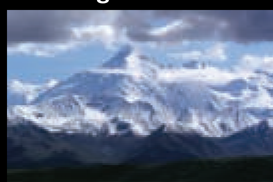
Declining Snow Cover



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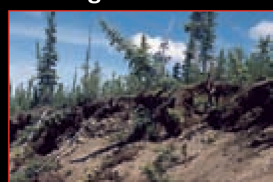
Thawing Permafrost



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As illustrated above, a warming climate has and will continue to have many impacts on Alaska. The study summarized inside this brochure considers only the effects of a few of these – thawing permafrost, retreating coastal sea ice, and increasing precipitation – on only one aspect of the state: public infrastructure. It is therefore only a small sample of the total costs of warming on the state.

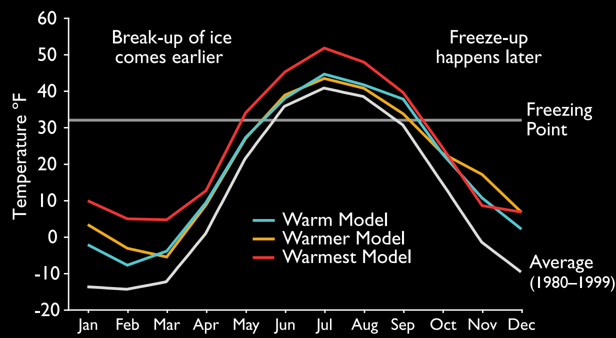
Map: ©Clifford Grabhorn

A warming climate is already causing permafrost to thaw, sea ice to retreat, and heavy rains to increase, and more of the same is projected as temperatures continue to rise. The costs of maintaining Alaska's public infrastructure will rise significantly as a result, costing the state billions of dollars in additional costs.

For the first time, researchers in Alaska have attempted to estimate what just a few of the results of a warming climate – thawing permafrost, increasing rain, and retreating sea ice along the coast – are likely to cost for one aspect of Alaska's economy: public infrastructure, such as roads, bridges, airports, schools, and water and sewer systems. Although the results are preliminary, they offer a general picture of the extra costs public agencies face as warming proceeds, and provide much–needed and new information for those considering the best policy approaches for addressing the myriad challenges presented by climate change. The key findings of this new study are briefly summarized in this brochure. The full technical report and a more extensive summary are available online at www.iser.uaa.alaska.edu.

This study involved assembling a database of Alaska's public infrastructure, estimating its value, and mapping its location. Climate model projections of future warming due to global emissions of greenhouse gases were then used to estimate how much extra the projected warming would cost the state in maintaining its existing infrastructure. There are plans to update and extend this research as more information becomes available.

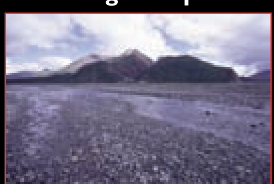
Monthly Average Temperatures in Barrow, Observed and Projected (2080)



©ISER, 2007, Source: IPCC, Special Report on Emissions Scenarios: A1B

The figure shows observed recent average temperatures for each month of the year during the period from 1980 to 1999 for Barrow, Alaska (gray line), along with climate model projections of these monthly temperatures by the year 2080. Note that under all of the model projections, ice break-up will come earlier and freeze-up later than at present.

Increasing Precipitation



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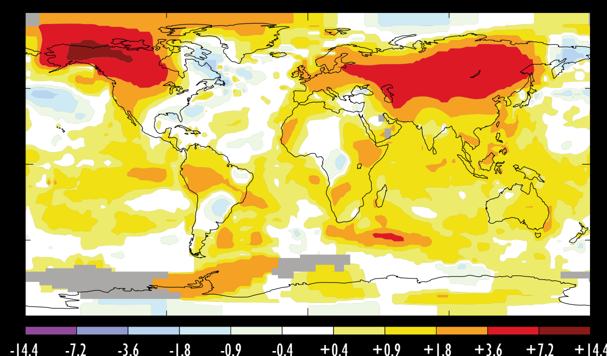
Insect Infestations

©The National Agricultural Library

Increasing Wildfires

©BLM Alaska Fire Service

Observed Temperature Change (°F)
Winter (Dec., Jan., Feb.) - 1949–2005



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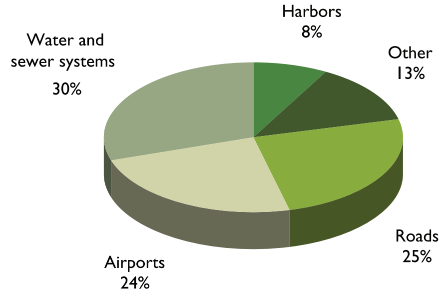
As the map illustrates, winter temperatures in Alaska have already risen between 5 and 10°F. In general, higher latitudes are warming more rapidly than the global average.

Likely Share of Extra Costs by 2030



Limitations of the Study

Privately owned infrastructure, such as homes, businesses, and industrial facilities, are excluded from this analysis. Counting of public infrastructure is incomplete due to data limitations (for example, data are not available for many military installations due to security issues). The Trans-Alaska pipeline was not included. The analysis only considers infrastructure already built today; it does not anticipate future infrastructure and the extra costs warming would impose on such projects as a planned natural gas pipeline.

Many assumptions about future warming as well as its impacts on infrastructure had to be extrapolated from a limited number of data points. Sea-level rise was not taken into account in this analysis.

Although three different climate models are used to illustrate three possible levels of future warming, all three models used the same emissions scenario, a middle-of-the-road scenario that assumes high economic growth and energy use, low population growth, and rapid technological advances. Higher and lower emissions scenarios were not analyzed. Thus the range of economic costs shown here is only a small part of the possible range. The actual costs will depend largely on the level of emissions of heat-trapping gases, with higher emissions resulting in more warming and higher costs.

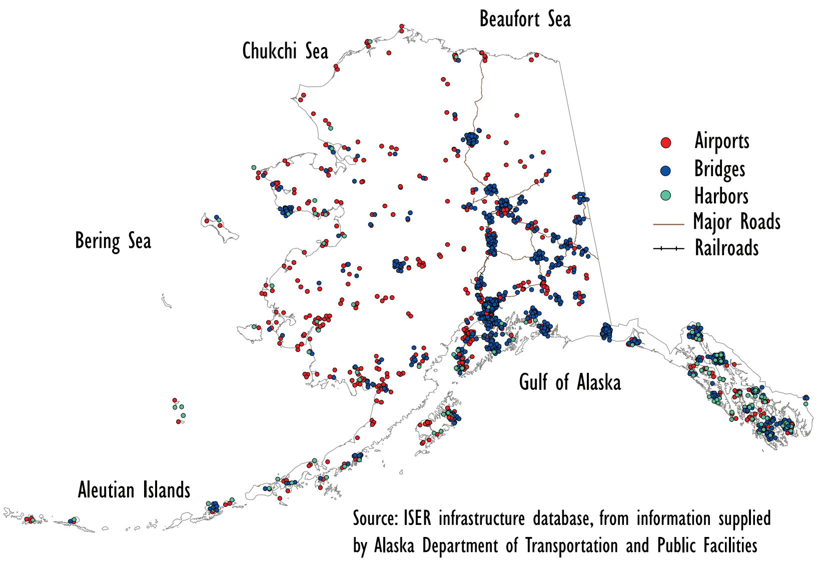
Key Findings

Assuming a middle-of-the-road increase in global greenhouse gas emissions, and assuming that strategic adaptations are made (anticipating and planning for continuing warming and its impacts on infrastructure) preliminary results suggest:

1. The cost to maintain Alaska's public infrastructure is expected to increase by 10 to 20% by 2030, costing the state an additional $4 to $6 billion.

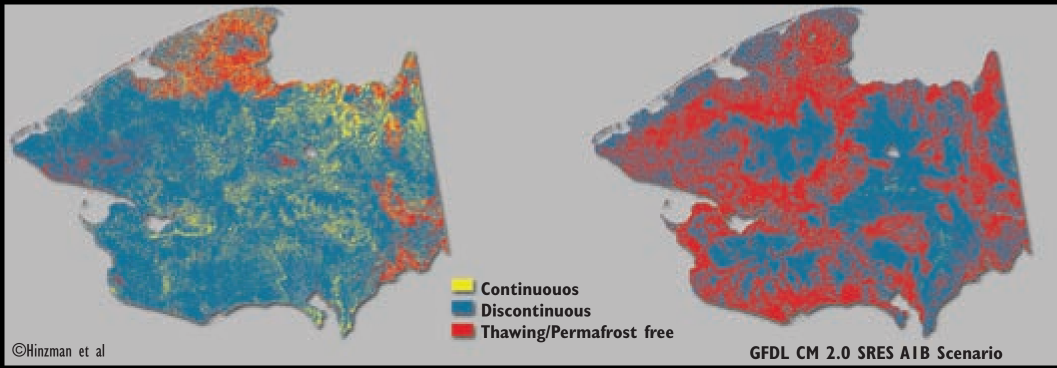
2. Roads and airport runways are projected to account for about half of the additional costs between now and 2030. Water and sewer systems would account for nearly a third of the costs.

Transportation Infrastructure in Alaska, 2006



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

Seward Peninsula Early 21st Century Estimated Permafrost Distribution | **Seward Peninsula Late 21st Century Estimated Permafrost Distribution**



Continuous (frozen ground occupies 90-100% of the land area)

Discontinuous (frozen ground occupies 10- 90% of the land area)

The maps show the extent of thawing projected to occur on Alaska's Seward Peninsula in this century under a moderate warming scenario.

3. **Public infrastructure most vulnerable is located on exposed coastal plains that are susceptible to flooding and erosion from both sides. As sea level rises, coastal permafrost thaws, and sea ice that once protected the coast retreats, these areas face more erosion from storms and the higher waves they produce. At the same time, intensifying precipitation increases the risk of rivers overflowing their banks.**

4. **The adaptations assumed in the analysis have a large effect on projected costs. Without these adaptations, the costs are projected to be much higher. For example, under the warmest model projections analyzed here, without adaptations, the extra costs due to warming would be about $12.3 billion by 2080.**

5. **By 2030, strategic adaptation could reduce the costs imposed by warming from 0 to 13%, depending on the extent of warming. By 2080, such adaptations could save from 10 to 45% of those costs. The projected savings are larger later in the century because agencies would have more time to apply strategic adaptations to changing conditions.**

Estimated Costs of Warming on Public Infrastructure With and Without Strategic Adaptations

(Billions of $, Net Present Value)

	Ordinary wear and tear (No climate change)	Extra Costs from Climate Change					
		Warm Model		Warmer Model		Warmest Model	
		No Adaptions	With Adaptions	No Adaptions	With Adaptions	No Adaptions	With Adaptions
2006–2030	$32	$3.6	$3.6	$6.1	$6.0	$7.0	$6.1
2006–2080	$56	$6.2	$5.6	$10.6	$7.6	$12.3	$6.7

Costs NOT considered in this analysis include the costs of protecting and/or relocating the many villages threatened by erosion

Coastal erosion at Kivalina, Alaska ©USACE, 2006

Projected Coastal Erosion at Newtok, Alaska

Projected coastal erosion at Newtok, Alaska ©USACE, 2006

Estimated Protection and Relocation Costs for Three Alaskan Communities

Community	Costs of Future Erosion Protection	Costs to Relocate
Kivalina	$15 million	$95–125 million
Newtok	$90 million	$80–130 million
Shishmaref	$16 million	$100–200 million
Totals	$121 million	$275–455 million

One example of costs not included in this analysis is the estimated cost of protecting and/or relocating coastal communities that are under imminent threat of destruction due to factors including sea-level rise, sea-ice retreat, and thawing of coastal permafrost. Three of these towns and the costs of erosion protection and relocation estimated by the U.S. Army Corps of Engineers are shown in this chart. Further, a report by the U.S. General Accounting Office found that 184 of 213 or 86% Alaska Native villages are threatened by erosion and flooding, and that rising temperatures are increasing their susceptibility.

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