Estimating the Future Cost of Alaska Public Infrastructure at Risk to Climate Change

May 2007

P. Larsen, O. S. Goldsmith, O. Smith, M. Wilson, K. Strzepek, P. Chinowsky, and B. Saylor

Research Objective

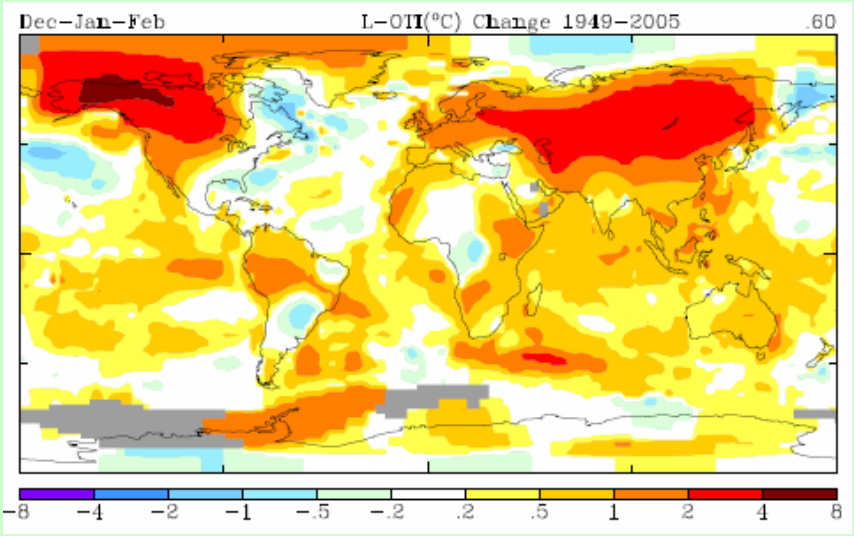
Question:

What *objective* insights can be made about the potential costs to Alaska public infrastructure from rapid climate change?

Answer:

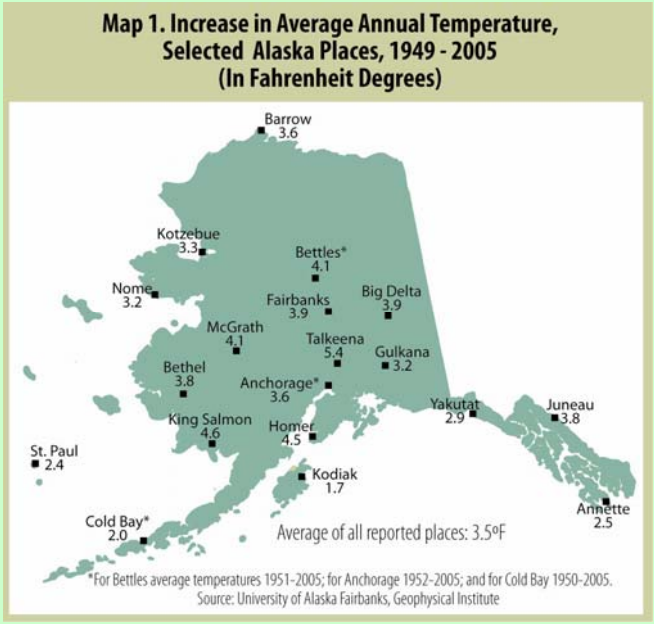
ISER-UAA has built a policymaking tool to estimate the additional replacement costs to public infrastructure due to climate change. Our preliminary model runs show a plausible range of costs by infrastructure type and area. Under any scenario, what we can say is that aggregate costs will total at least several billion of today's dollars.

“Recent” Climate Change

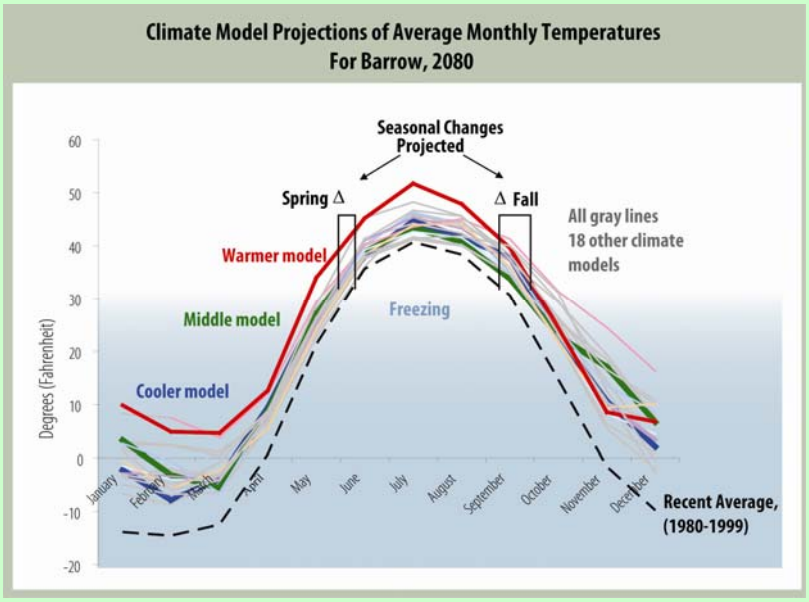


Source: NASA, GISS (2007)

“Recent” Climate Change



"Projected" Climate Change



Source: Lawrence Livermore National Laboratory, NCAR, ISER (2006,2007)

Climate Change Effects Public Infrastructure Value

1. *Melting Permafrost*

Melting permafrost causes roads and foundations to prematurely buckle.

2. *General Sea-level Rise*

Sea-level rise directly damages adjacent built environment and accelerates erosion.

3. *Rapid Coastal Erosion*

Increased storm activity/sea-level rise rapidly erodes exposed coastal communities.

4. *Increased Flooding*

Floods damage bridges, roads, landing strips, and water utility systems, etc.

5. *Increased Fire Activity*

Fires directly damage built structures including government buildings.

Example of Rapid Coastal Erosion Impacting the Built Environment

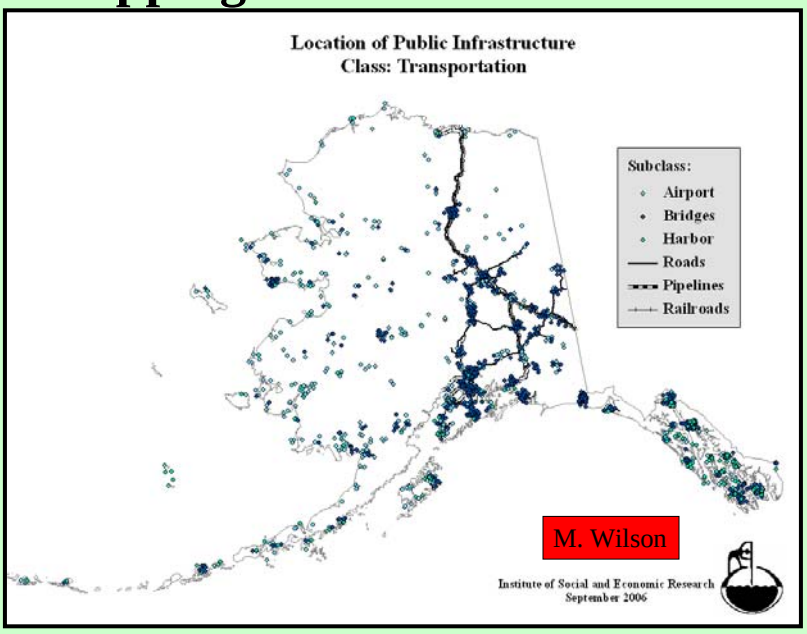
Example of Rapid Coastal Erosion Impacting the Built Environment

Source: U.S Army Corps of Engineers (2006)

Example of Melting Permafrost Impacting the Built Environment

Source: Vladimir Romanovsky, University of Alaska Fairbanks; UCAR (2007)

Mapping Alaska Infrastructure



Model Functional Form

r = Real Discount Rate (i.e. 2.85%)
i = Year
j = Infrastructure Type

Base Case

$$\theta_j = \frac{\text{Replacement Value}_j}{\text{Basecase Useful Life}_j}$$

$$\text{PV}_{\text{Base}} = \sum_{j=1}^{20} \sum_{i=2006}^{2030} \frac{\theta_j}{(1+r)^{i-2006}}$$

Climate Change

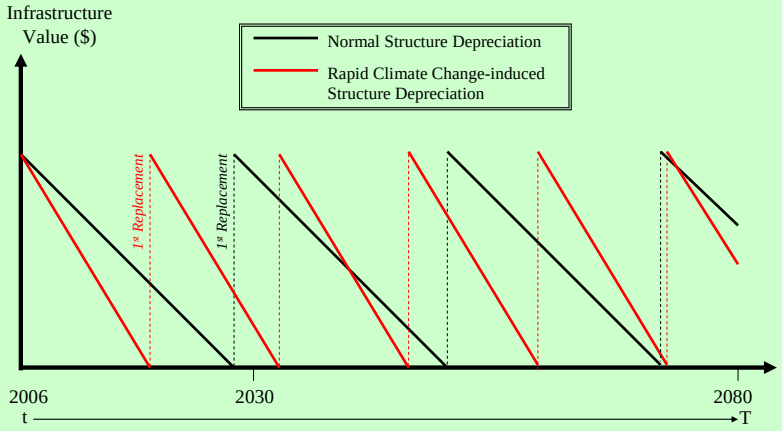
$$\Delta_j = \frac{\text{Replacement Value}_j}{\text{Adjusted Useful Life}_j}$$

$$\text{PV}_{\text{Climate Change}} = \sum_{j=1}^{20} \sum_{i=2006}^{2030} \frac{\Delta_j}{(1+r)^{i-2006}}$$

$$\Phi_{2030} = \text{PV}_{\text{Climate Change}} - \text{PV}_{\text{Base}}$$

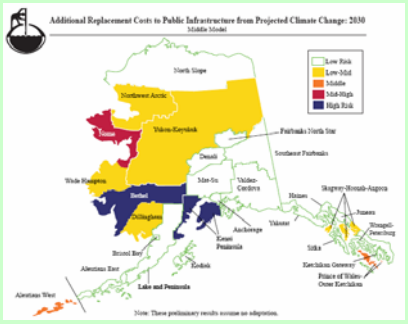
Φ_{2030} = Additional Public Infrastructure Replacement Costs from Climate Change

Calculating the Exposure of Alaska Infrastructure to Climate Change

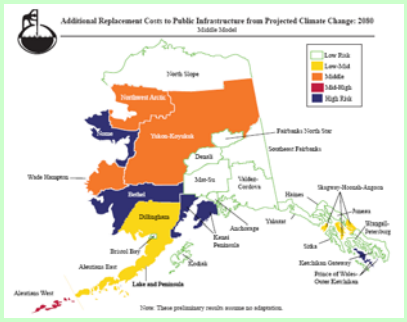


Mapping Additional Replacement Costs from Climate Change

2006-2030



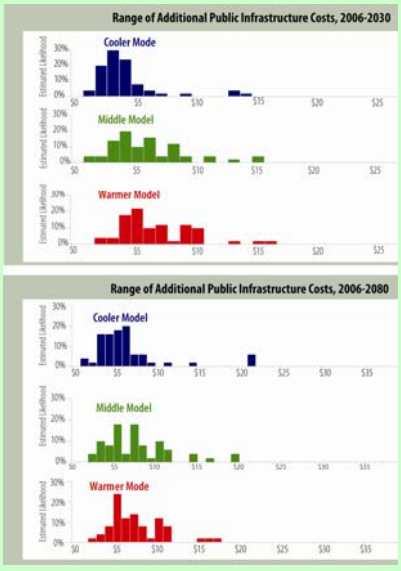
2006-2080

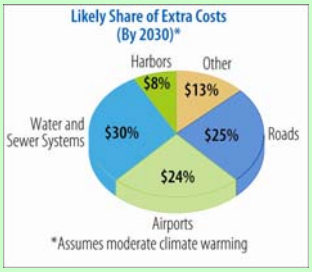


Source: ISER (2007)

Value of Infrastructure *Vulnerable* to Climate Change

Estimated Likelihoods





***Preliminary* and Assumes Plausible Adaptations**

Source: ISER (2007)

Conclusion

- Regardless of cause, effects of climate change are being observed in many parts of Alaska.
- Future projections show a consensus of significant changes in the foreseeable future, particularly for places where the projected average annual temperature goes from below freezing to above freezing *and* along coastal/interior floodplains.
- Damages to infrastructure could be large (i.e. *several billions of today's dollars*), but there is little reliable information "on the ground" detailing the degree and location of impacts.
- Hewlett/NCEP/ACF/RurALCAP sponsored research will allow ISER/UAA School of Engineering to continue to build a model to roughly estimate these impacts and facilitate the adaptation/mitigation debate.

Final Thoughts from the U.S.A.R.C….

" Expected values of relocation and rehabilitation can be developed, given estimates of per-mile design and construction costs. A *master plan* of climate-change-induced major relocation and rehabilitation projects can be formed with this information."

-U.S. Arctic Research Commission, 2003