



Vulnerability and Cost of Climate-Related Impacts

Permafrost thawing has probably had the greatest economic impact in Alaska so far and may present the greatest vulnerability in the future. In Siberia, Russian engineers are very concerned about the safety of apartment buildings and pipelines in permafrost terrain. Many of these have already failed (Fig. 15). Hundreds of these structures may become unsafe within 30 years if present climate trends continue since the piles on which the buildings rest are thawing out (Khrustalev, 1999; Weller and Lange, 1999). Roads, building, airfields and pipelines are under threat in the entire discontinuous permafrost zone of the Arctic.

Cole (1999) estimated that it has cost on average about \$35M/year in recent years for road repairs in permafrost terrain in Alaska, severe storm damage to electric transmission lines, and effects of thawing on ice winter roads. Some of these costs are related to a change in climate, others to extreme weather events. Other costs of climate-related impacts are difficult to assess at present since there are many non-climate parameters that also play a role. This is particularly true for the Alaskan fisheries. Some fisheries have done very well recently, others have crashed. Future climate changes could halve or double average harvests, resulting in hundreds of millions dollars gains or losses annually (Knapp, 1999). Table 5 shows the sensitivities (high, medium, low, or none) of economic sectors in Alaska to various agents of change (modified

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from Weller and Lange, 1999). The resulting economic impacts can be either positive or negative, depending on the direction of change. More on whether they are likely to be positive or negative in the future can be found elsewhere in this report.

Coping and Adaptation Strategies

Responsible institutions in Alaska are not generally aware of the problems resulting from climate change that will be witnessed in the future. This awareness is important as there are some coping and adaptation strategies that can be applied now. They include:

- Long-term forecasting and planning. The greater the extent to which one can anticipate the longer-term

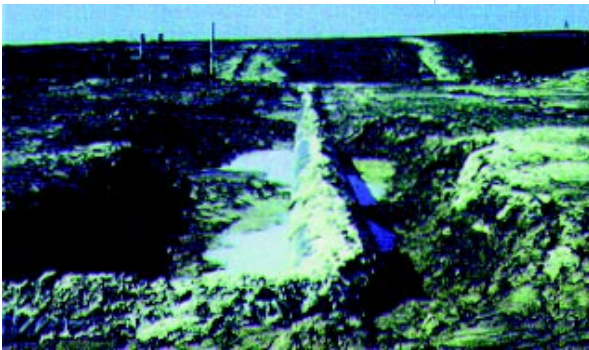


Fig. 15. Typical examples of the effects of permafrost thawing on buildings and pipelines in Siberia. Photos by S. Yu. Parmuzin.

effects due to climate change, the better one can adjust to changes. This is true whether the impacts are in fisheries, forestry or other economic activities. Even though long-term forecasts may be highly uncertain, they may still be valuable.

- Changes in management and political institutions. How management and political institutions are designed will affect the nature and scale of economic and social disruptions caused by climate change. For example, political agreement over fisheries allocations should recognize that significant future changes in harvest levels are not only possible but also likely.
- Public expenditures to reduce public risk. In Alaska, engineers continue business as usual by building roads, houses and other infrastructure on permafrost and repairing the damage later at great cost. Through planning and by using modern and initially more expensive techniques it may be possible to avoid these continuing repair costs in future years.
- Incentives to reduce public cost and risks. An aggressive strategy to reduce the cost of climate-related impacts such as forest fires would be a set of policies that puts the cost on the individuals who settle in risky areas, rather than on society. Also, since most areas now at risk from damaging forest fires in Alaska have only recently been settled, infrastructure for economic development could only be provided in areas that are already densely settled, thus reducing the fire risk.
- Native strategies. While scientists often view change as a short-term and rapid phenomenon, Native residents can live with long-term uncertainties and generally can cope with change. There are many examples of successful Native adaptations to climate change across the arctic region, both in pre-history and in modern times. Factors that enhance Native adaptability and decrease vulnerabilities to climate change include maintaining a diverse economy, use of alternate natural resources, high mobility, customary sharing of subsistence resources, and relying on local environmental knowledge.

Information and Research Needs

Impact assessments provide an excellent means of interdisciplinary analysis and synthesis of change; this is the underlying philosophy of the ongoing regional impacts assessments of the U.S. Global Change Research Program. Key questions that need to be answered are:

1. What are the likely regional impacts of global change (Alaska and the Bering Sea region in our case)?
2. What are the available data bases to assess these impacts?
3. What are the gaps in information needed to conduct the impacts assessment?
4. What else is needed to adequately conduct the impacts assessment?

reductions in sea ice extent in the Arctic have been observed, associated with climatic warming, and permafrost on land is thawing rapidly, leading to coastal and inland areas becoming free of permafrost. While the biological components of the arctic ecosystem appear to react to many different environmental variables in the atmosphere and the ocean, climate-driven variability is significant. It appears that climate has caused relatively rapid shifts in the organization of the marine ecosystem, and that changes over periods of decades may have larger effects than those over yearly periods. Less data are available to assess the impacts of climate change on economic activities, and future projections are difficult due to the many additional complex factors that also affect regional economic performance.

Many problems remain in adequately assessing impacts. Data sources are sparse, particularly data on the ocean, and analysis and synthesis efforts need to bring the diverse data and information sets together. For example, standardized GIS data formats are needed to allow a synthesis of information from different regions. Additional field work is also needed in some areas despite the fact that there are many existing and planned research projects in the region. Future workshops must lead to iterative improvements of the entire impacts assessment process.

Conclusion

Our five workshops were attended by a total of about 400 people. The affiliations of the attendees in the first four workshops are listed below. From the beginning we involved people from other countries bordering Alaska (Russia and Canada) or with economic or research interests in the Bering Sea (Japan and China). The fifth workshop, unlike the others, was an international affair that attempted an assessment of global change impacts for the entire Arctic, including Alaska. Attendees of that workshop are not included in the percentages below.

| Affiliation | Attendance (%) |
|----------------------|----------------|
| Academia | 37 |
| Government | 28 |
| Industry/Private | 18 |
| NGO's | 5 |
| Foreign Institutions | 12 |
| Total 100 | |

As the workshops progressed from year to year, participation by stakeholder groups beyond academia and govern-

ment was expanded, including members of the fishery and forestry industry in Alaska, the big international petroleum companies, power and energy producers in Alaska, consultants and private individuals. It also increasingly included representatives of the Alaska Native community. This trend can be seen clearly in the numbers presented in the appendix.

We have attempted to make the information from our workshops available to the general public, to schools, stakeholders, and decision makers in easily understood forms by printing brochures and posters, and through talks in various Alaskan communities. While there is a long way to go to get our message across, we believe that we have made a useful start. We plan to have additional workshops to refine our assessments and to let the people of Alaska know what future climate change might mean to the State and its inhabitants.

