Resource Brief
Alaska

National Park Service
U.S. Department of the Interior

Inventory and Monitoring Program
Alaska Region

Permafrost and Climate Change

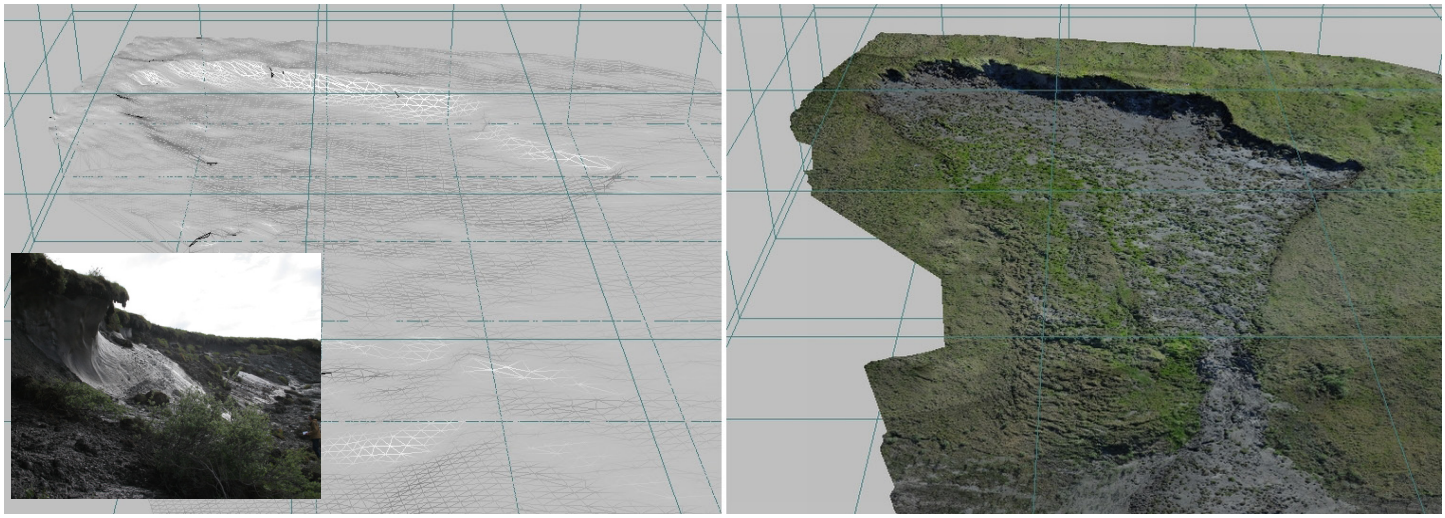

Photo: Dave Swanson/NPS

The photo and 3D model show a retrogressive thaw slump in Noatak National Preserve. Slumps result from a combination of land subsidence due to thaw of large ice masses and downhill transport of sediment by sliding or water erosion.

Background

Permafrost is ground that remains frozen longer than two consecutive years. It dominates the landscape in northern Alaska and is found in 10 of Alaska's 16 national parks. Significant thaw of permafrost is considered likely with future climate change (IPCC 2007). Permafrost has previously been identified by the Arctic (ARCN) and Central Alaska Networks (CAKN) as a vital sign in Alaska's national parks. *Existing monitoring efforts have been enhanced as part of the National Park Service's expanding commitment to understand and respond to climate change and its potential effects as outlined in the Climate Change Response Strategy developed in September 2010*. The enhanced efforts combine direct and indirect measurements of temperature and landscape features and utilize existing partnerships to increase overall understanding of status and trends of permafrost conditions in Alaska.

Photo: Nichole Andler/NPS

Muskox occur in Bering Land Bridge National Preserve and are an Arctic adapted species that may be effected by climate change.

Enhanced Monitoring

The goal of the Alaska Region's expanded permafrost monitoring effort is to understand the magnitude of thawing and the current and potential effects on ecosystems in Alaska's national parks. There are several challenges unique to permafrost monitoring, including the vast area of roadless wilderness and wide variety of responses by the landscape to permafrost thaw. With these challenges in mind, the monitoring team, which includes partners from the Arctic and Western Alaska Landscape Conservation Cooperatives and the U.S. Fish and Wildlife Service, has developed a plan that combines direct and indirect measurements to gain a better understanding of permafrost and thaw cycles. Protocols from both ARCN and CAKN are being applied to this broader, coordinated effort. This multi-faceted approach will result in an efficient, more robust monitoring program.

Maps of permafrost location and condition for all parks in ARCN and CAKN will be developed using models that utilize near surface ground temperatue data as well as data from existing landscape and soil inventories. Near surface ground temperatures (0 to 2 m), a direct measurement, is being collected on a continual basis. Measurements are taken using temperature sensors located at existing weather monitoring stations, new weather monitoring stations installed in 2011, and others slated for installation in 2012. Near surface ground temperatures will be monitored in all parks within the ARCN and CAKN as a result of this project.

Putting it All Together

The dynamics of permafrost landforms will be monitored via several indirect measurements. Satellite imagery is being used to inventory natural features associated with permafrost. Features indicative of thaw, such as areas covered by water or bare soil, are being mapped using moderate resolution imagery. Where rapid thawing and conspicuous changes are occurring, such as slumping or landslides caused by melting, 3D models using advanced technologies like LIDAR and stereophotogrammetry are then applied to focus areas.

Additional monitoring efforts are also being considered and may be included in future protocols. Periodic temperature measurements from deep boreholes (up to 20 m) taken from areas adjacent to the parks may be analyzed and summarized. The thickness of the active layer, the area between the ground surface and permafrost layers subject to seasonal frost, may be measured during annual summer thawing at sites with fine-grained soils that are accessible by road. Active layer monitoring would follow an established international protocol established by the Circumpolar Active Layer Monitoring Network (CALM).

Thermokarst, the term collectively applied to subsidence features related to permafrost thaw, includes slumps and depressions in the landscape and the formation, enlargement or drying of lakes and other bodies of water among other features. Effects of thermokarst include erosion, associated landslides, increased sediment loads in lakes and streams, changes in vegetation growth patterns and altered nutrient cycles.

This monitoring effort will result in an inventory of areas likely to contain permafrost, a current assessment of permafrost conditions, trends in melting and effects of melting for eight parks in Alaska. This information will be used to inform decisions about park management. Results will be organized into a technical report summarizing data. In addition, an interpretive document summarizing permafrost changes will be made available to park managers, policy makers, the general public and others. Data will be made available via online resources. Permafrost thaw features in many of the national parks within ARCN have already been mapped, and this expanded effort will focus on unmapped parks in which areas of permafrost occur. Protocols for this expnded effort were finalized in mid-2011. Progress reports and initial results are expected in early 2012.

Photo: Larissa Yocum/NPS

Photo: Larissa Yocum/NPS

Images showing two perspectives of Hook's Hole thermokarst in the Toklat Basin within Denali National Park. The large cave-like space and tilted trees are a result of thawing permafrost. Notice the person in the top image for scale.

Permafrost and Rising Temperatures

Monitoring changes in permafrost condition is a high priority due to the potential for accelerated thaw rates which may fundamentally change ecological processes across major portions of the Alaska landscape. A multi-tiered approach utilizing existing partnerships, established protocols and regional support is being applied to expand this program. A combination of on-site measurements, satellite imagery, and modeling will provide information needed to form a baseline data set of permafrost metrics in Alaska's national parks. Continued monitoring of permafrost areas will help researchers, managers, and the public understand and respond to the potential effects of climate change on permafrost. The results from this enhanced monitoring effort will be made available via online databases.

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